The Effects of the DRG-Based Prospective Payment System on Quality of Care for Hospitalized Medicare Patients

Final Report

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PREFACE

This report presents the design, methods, and results of a RAND study entitled "The Effects of the DRG-Based Prospective Payment System on Quality of Care for Hospitalized Medicare Patients." The study was funded by the Health Care Financing Administration. This volume is the second of a series documenting the design, methods, and results of a four-year evaluation that began in 1985. It presents material published in a peer-reviewed medical journal (see below) and a series of appendixes designed to supplement that material.

The study used a time series design to measure quality of care in 1981–1982, before the implementation of the prospective payment system (PPS), and in 1985–1986, after PPS implementation. Quality of care was judged using a clinically detailed review of patients' medical records and studying mortality, readmission, and use of nursing homes after hospital discharge. Data were collected for a nationally representative sample of Medicare patients at least 65 years of age who were hospitalized with one of the study's six study diseases or conditions: congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture, and depression.

Other publications from this study as of this date are listed below:

Kahn, K. L., R. H. Brook, D. Draper, et al., "Interpreting Hospital Mortality Data: How Can We Proceed?" *JAMA*, Vol. 260, No. 24, pp. 3625–3628, 1988.

Kahn, K. L., M. R. Chassin, L. V. Rubenstein, et al., *Medical Record Abstraction Form and Guidelines for Assessing Quality of Care for Hospitalized Patients with Congestive Heart Failure,* RAND, N-2798-HCFA, December 1988.

Kosecoff, J., L. V. Rubenstein, K. L. Kahn, et al., *Medical Record Abstraction Form and Guidelines for Assessing Quality of Care for Hospitalized Patients with Acute Myocardial Infarction*, RAND, N-2799-HCFA, December 1988.

Sherwood, M. J., K. L. Kahn, J. Kosecoff, et al., *Medical Record Abstraction Form and Guidelines for Assessing Quality of Care for Hospitalized Patients with Hip Fracture,* RAND, N-2800-HCFA, December 1988.

Roth, C. P., K. L. Kahn, M. J. Sherwood, et al., *Medical Record Abstraction Form and Guidelines for Assessing Quality of Care for Hospitalized Patients with Pneumonia*, RAND, N-2801-HCFA, December 1988.

Rubenstein, L. V., J. Kosecoff, K. L. Kahn, et al., *Medical Record Abstraction Form and Guidelines for Assessing Quality of Care for Hospitalized Patients with Cerebrovascular Accident*, RAND, N-2802-HCFA, December 1988.

Wells, K. B., J. Kosecoff, M. J. Sherwood, et al., *Medical Record Abstraction Form and Guidelines for Assessing Quality of Care for Hospitalized Patients with Depression,* RAND, N-2803-HCFA, December 1988.

Kahn, K. L, L. V. Rubenstein, M. J. Sherwood, and R. H. Brook, *Structured Implicit Review for Physician Implicit Measurement of Quality of Care: Development of the Form and Guidelines for Its Use*, RAND, N-3016-HCFA, September 1989.

Rubenstein, L. V., K. L. Kahn, E. R. Harrison, et al., *Structured Implicit Review of the Medical Record: A Method for Measuring the Quality of Inhospital Medical Care and a Summary of Quality Changes Following Implementation of the Medicare Prospective Payment System*, RAND, N-3033-HCFA, 1991.

SUMMARY

INTRODUCTION

In an effort to control rising health care costs, the federal government, in 1983, established a prospective payment system (PPS) to reimburse hospitals for inhospital care of Medicare patients. PPS changed the way Medicare reimbursed hospitals from a cost or charge basis to a prospectively determined, fixed-price system in which hospitals are paid according to the diagnosis related group (DRG) into which a patient is classified. The fixed payment per patient provides financial incentives for hospitals to reduce both length of stay and intensity of care, giving rise to concerns that the quality of care may have declined under PPS.

In October 1985, The RAND Corporation began an evaluation of the impact of the DRG-based PPS system. The project was funded by the Health Care Financing Administration (HCFA) and was undertaken in collaboration with the Professional Review Organizations (PROs) in five states. The objective of this four-year study was to determine whether PPS cost-containment efforts have affected the quality of care received by hospitalized Medicare patients.

METHODS

Six conditions were selected for this evaluation: congestive heart failure, acute myocardial infarction, hip fracture, pneumonia, cerebrovascular accident, and depression. These conditions were selected because they occur frequently and, except for hip fracture and depression, cause a large number of deaths. In addition, well defined diagnostic criteria exist for these diseases, and their treatment was relatively stable from 1981 to 1986. Finally, for these diseases, the patient's medical record contains the information necessary to assess patient sickness at the time of hospital admission and the quality of hospital care. Hip fracture and depression were chosen to provide data about care for surgical and psychiatric conditions; these data supplement the information provided by the four medical conditions. The results of the depression analyses will be presented at a later time.

Five states were selected for study, each from a different geographic region of the nation: California, Florida, Indiana, Pennsylvania, and Texas. Each state was divided into 10 to 12 study areas, and we gathered data from a sample of four to eight areas in each state, for a total of 30 areas.

To evaluate the impact of PPS, we used a time series design in which we compared patients hospitalized before implementation of PPS (January 1981 to December 1982) with patients hospitalized in the same institutions following PPS implementation (July 1985 to June 1986). We collected 20 percent of the total patient sample in 1981, 30 percent in 1982, and 50 percent in the post-PPS time period.

Our sample is representative of patients nationally with respect to hospital size, teaching intensity, percentage of Medicare admissions, and size of the city in which the hospital is located. We oversampled city/county hospitals and hospitals with many Medicaid patients to better estimate the effect of PPS on poor patients.

Study Sample

Of the 305 hospitals asked to participate, 297 actually did so. The planned study sample was 17,000 patients. To collect data on this number of patients, 21,925 medical records were selected for review. During medical record review, 5,167 patients did not meet clinical criteria for having the selected diseases (even though the record was coded as such), and these were excluded from the study. Hospitals were unable to locate 870 records. The final study sample consisted of 16,758 patients.

Measuring Quality of Care

We used both explicit and implicit measures to assess quality of care. With explicit measurement each patient's care was compared to predetermined criteria. With implicit measurement each patient's medical record was assigned a quality of care rating based on a physician's judgment of the adequacy of the care. A 10 percent subsample of the entire study sample of medical records underwent implicit review. The sample of medical records receiving implicit review was evaluated by physician specialists from each of the five study states.

Explicit Measurement. We developed disease-specific abstraction forms to collect explicit data from the patient's medical record about sickness at admission, process of care, inhospital outcomes, and patient status at discharge.

To develop the explicit abstraction form, we reviewed the literature on quality of care for patients hospitalized with each of the six diseases and developed recommendations on what information about sickness at admission and processes and outcomes of care should be abstracted. We then invited PRO-selected physicians from the five states to participate in a one-day panel meeting to advise us on which data to collect. In addition, we sought advice about whether the suggested information could be found in the medical records of patients with each disease in each state.

Following the panel meeting, we pilot-tested the abstraction forms on medical records from each of the participating states, to determine if items recommended for selection by the physician panel were actually contained in the medical record and to take note of the different styles of recording of information across states and types of hospitals (i.e., university, community, or rural). After analysis of the pilot study, we finalized six disease-specific abstraction forms.

After completing a section on exclusion criteria to verify the patient's eligibility for the study, data collectors used these abstraction forms to collect information about each patient's acute and chronic, morbid and comorbid conditions that were present at admission. We then collected process data that were applicable both to all patients and to a given patient's particular clinical situation. For example, we collected information about the completeness of a fever workup only for patients with a temperature at or above a given level. We next collected clinical outcome data including information on death, diagnoses that were made during the hospitalization, and symptoms, signs, or abnormal laboratory values that occurred during the hospitalization. Finally, we obtained information from HCFA files on whether the patient died, was readmitted, or resided in a nursing home within 30 and 180 days of hospital admission.

Implicit Measurement. In developing disease-specific instruments for implicitly measuring quality of care, we first reviewed the literature on quality of care for patients hospitalized with each disease and the literature on how to do implicit review. We then invited PRO-selected physicians from the five study states to participate in six disease-specific panel meetings to discuss and test implicit measures of quality of care. Physicians were asked to detail the problems they had previously experienced in implicitly reviewing records for purposes of inhospital assessment (e.g., morbidity and mortality conferences) or PRO review. In addition, we sought advice about the way medical records might differ by type of hospital and geographic area so that the implicit review form for measuring quality of care could be developed for use in all kinds of acute care general hospitals in the United States.

From this work, we developed disease-specific Structured Implicit Review forms to guide physicians as they used the medical records to implicitly assess quality of care. For each item in each disease we developed guidelines to encourage consistency in the way the items were interpreted by physician reviewers. Physicians were asked to review medical records and to use their judgment to assess sickness at admission, processes of care, status at discharge, and inhospital outcomes. Our intent was to increase the reliability of implicit physician quality of care review while preserving the subtlety of physician judgment.

The Structured Implicit Review form specifies each part of hospital care to be judged (e.g., initial data gathering, technology use, and medication use), and provides guidelines for measuring care in each area. The basic principle underlying the guidelines is that adequate care in the United States is care that minimizes the risk of complications, maximizes the likelihood of a good outcome, and maximizes humane treatment of the patient at a level achievable by motivated practitioners under average conditions at average U.S. hospitals. Physician reviewers were asked to avoid adjusting ratings according to guesses about the size or type of hospital in which a patient was treated.

Data Collector Training, Abstraction, and Monitoring

An initial group of nurses and medical records personnel experienced with the gathering of clinical data was selected by the PROs to perform explicit data collection. Using medical records, the group was then screened for abstraction skills. After demonstrating adequate skills, 52 data collectors were invited to participate in a 14-day intensive training session at RAND. Data collectors were taught how to identify the proper medical record for abstraction and how to abstract data from the record. They were also trained in the collection of additional data, such as adding supplemental clinical information verbatim in the margins of the abstraction forms and attaching photocopies of specified pieces of data to the forms (e.g., chest X-ray reports, admission histories and physicals, and discharge summaries).

During the period of data collection, abstractors were monitored and feedback was given to data collectors who were identified as having problems. Additional fieldwork was supervised by a project manager who was familiar with the hospital in which the abstraction took place. In addition, each completed abstraction form was reviewed by both a physician and a nonphysician to assess internal consistency and to verify that the data collector's coding was consistent with the supporting clinical data attached to the form. Records with discrepancies that could not be resolved during the review process were returned for reabstraction.

During the period of data collection, the research team conducted supplementary training sessions in the field, monitored the quality of data collection through regular field visits, scheduled phone calls, and staffed a physician telephone hotline.

Analysis

For each disease, we studied outcomes before and after adjustment for patient sickness at admission. Specifically, we measured mortality inhospital, 30 days after admission, and 180 days after admission, as well as inhospital nonfatal complications. In addition, we measured length of stay, discharge destination, nursing home stay six months after discharge, and readmission rates pre- and post-PPS.

To develop disease-specific sickness-at-admission scales, we used logistic regression of death 30 and 180 days after admission on sickness-at-admission variables. We collected an average of 73 sickness variables per disease, but our final sickness-at-admission scales predicting mortality within 30 days of admission are, on average, weighted sums of 19 variables. These scales explain about 25 percent of the variance in mortality for patients with acute myocardial infarction, pneumonia, or cerebrovascular accident.

We used clinical judgment and Likert scales to construct five detailed explicit process scales and one overall process scale. The scales measured physician cognitive diagnostic process, nurse cognitive process, technical diagnostic process, technical therapeutic process, monitoring with telemetry, and the intensive care unit. Compliance was high for most of the approximately 100 criteria per disease, but significant differences in mortality were apparent for patients receiving good as compared with poor process of care. The positive relationship between measures of process and outcome helped to validate our explicit process scales. We also found a positive relationship between process and outcomes with our implicit measures. In addition, we demonstrated a strong relationship between our explicit measures of process of care and quality of care as measured by implicit review of the medical record by physicians.

To summarize the changes in quality of care associated with the implementation of PPS, we compared sickness at admission, process (both implicit and explicit), and outcomes scales before and after PPS implementation. When appropriate we adjusted for changes in sickness at admission. For example, in making outcome comparisons pre- and post-PPS it is necessary to adjust for admission sickness, so that observed outcome differences are not attributable simply to changes in how sick patients are when they arrive at the hospital.

To strengthen our pre- post-PPS comparisons, we supplemented them with an estimate of the impact on mortality of each of the described changes associated with PPS, with trend analyses to see if post-PPS values were consistent with pre-PPS trends, and with patient subset analyses, to see if post-PPS changes were consistent across patient subgroups.

Confidentiality

To maintain confidentiality of hospitals and patients for the explicit data, coded identifiers were assigned to hospitals and patients. No identifying information about physicians was obtained. For the implicit review, all medical records were de-identified with respect to hospital, physician, and patient name before physician review.

RESULTS

This report presents results for five of the six diseases examined. The analysis of depression has not yet concluded and the results for that disease will be reported elsewhere.

Sickness at Admission and Length of Stay

Following PPS implementation, patients are sicker at the time of hospitalization. We estimate that, if everything else had remained the same, the mortality rate 30 days after admission for our five diseases combined would have been 1.0 percentage points higher in the post-PPS period than its value (15.4 percent) in the pre-PPS period, just from the rise in admission sickness. The rise in sickness at admission was observed in all five diseases and was statistically significant for patients with pneumonia and hip fracture and for all five diseases combined.

Length of stay dropped significantly for each of the study diseases. Hospitalizations were shorter by 3.4 days on average—a 24 percent decline across the five diseases combined.

Process of Care and Stability at Discharge

For most process measures, better process was associated with better inhospital outcomes. As process changes from good to poor, the risk of inhospital death increases significantly, with relative risks for death within 30 days ranging up to 1.7, depending on the condition and type of process measure examined.

For all of our process measures, process of care improved after PPS implementation. This is true for physician cognitive assessment, nurse assessment, use of diagnostic and therapeutic technologies, and for monitoring with intensive care and telemetry.

Patients were sicker or less stable at discharge during the post-PPS period than they were in the pre-PPS period. Instability at discharge is also strongly related to postdischarge mortality. Patients discharged with at least one instability are 1.6 times more likely to die within 90 days after discharge than patients discharged without instability. During the pre-PPS period, 15 percent of patients were discharged with instability; post-PPS this figure is 3 percentage points (20 percent) higher. When discharge instability and sickness are combined with other related factors such as discharge to a nursing home, total discharge problems have increased enough post-PPS to raise death rates 180 days from discharge 0.2 to 0.9 percentage points, depending on disease.

Patient Outcomes

Mortality. After adjustment for changes in sickness at the time of hospital admission, we found a reduction in inhospital mortality for all five diseases after the introduction of prospective payment. Adjusted inhospital mortality for the five diseases combined dropped from 16.1 percent to 12.8 percent. The 3.3 percentage point reduction in inhospital mortality (95 percent confidence interval 2.3 percent to 4.3 percent) was significant ($p < 0.01$), as was the reduction in mortality for four of the five diseases.

When we studied mortality in a fixed time period after hospital admission, adjusted mortality rates for all five diseases remained lower post-PPS compared with pre-PPS. However, the relationship was no longer statistically significant at the 0.01 level. Unweighted adjusted mortality rates 30 days after admission for the five diseases combined were 16.7 percent pre-PPS and 15.7 percent post-PPS, a difference of 1.0 percentage points (95 percent confidence interval -0.1 percent to 2.1 percent, $p = 0.07$). After reweighting the sample to represent the nation, the 30-day postadmission adjusted mortality rates were slightly different from the unweighted values (16.5 percent pre-PPS compared with 15.4 percent post-PPS, difference 1.1 percentage points, $p = 0.04$).

The adjusted mortality rates 180 days after admission for the five diseases combined were 29.6 percent pre-PPS and 29.2 percent post-PPS. Thus, almost one-third of Medicare patients hospitalized with the five study diseases expired within six months after admission. For congestive heart failure, cerebrovascular accident, and hip fracture, mortality dropped post-PPS (significantly for hip fracture: 17.8 percent pre-PPS, 14.8 percent post-PPS, $p < 0.05$), whereas for acute myocardial infarction and pneumonia, mortality rose post-PPS.

Discharge Destination. For the five diseases combined, the proportion of patients with a preadmission residence of home and a discharge destination of home was 77 percent pre-PPS and 73 percent post-PPS ($p < 0.05$), with the most important difference being for hip fracture patients (56 percent pre-PPS and 48 percent post-PPS, $p < 0.05$). We found little change in the discharge destination for patients admitted from a nursing home. Overall, 95 percent of all patients admitted from a nursing home who also survived hospitalization returned to a nursing home, and this did not vary significantly by disease or by time period.

Prolonged Nursing Home Stay. In studying prolonged nursing home stay, we identified patients in three of our five states whose preadmission residence was home and who were still alive seven months after hospitalization. For the five diseases combined, 8 percent of such patients in two states were in some type of nursing home (skilled or residential) approximately six months after the hospitalization, whereas 2 percent of such patients in the third state were in a skilled nursing home.

Across the three states we found that 5.6 percent of patients in the pre-PPS period and 6.6 percent of patients in the post-PPS period were in nursing homes six months following hospitalization ($p > 0.05$). This finding was not statistically significant in any state.

Readmissions. We found that the number of patients who died or who had at least one readmission within 180 days of admission, for the five diseases combined, was unchanged during the two time periods: 57 percent pre-PPS and 56 percent post-PPS ($p > 0.05$). Results varied slightly by disease, with fewer congestive heart failure, pneumonia, and hip fracture patients post-PPS either dying or being readmitted ($p > 0.05$) but more patients with acute myocardial infarction suffering one of these two outcomes post-PPS ($p < 0.05$).

The proportion of those patients discharged alive within one year of admission who had at least one hospital readmission was two percentage points lower post-PPS for all diseases combined and was lower for each disease individually except acute myocardial infarction ($p < 0.05$ for congestive heart failure and hip fracture; $p > 0.05$ for the other diseases individually and for the five diseases combined). Across all diseases except acute myocardial infarction, the total number of days spent in the hospital within one year of the study hospitalization was two days less post-PPS than pre-PPS ($p < 0.05$ for congestive heart failure, pneumonia, hip fracture, and the five diseases combined).

Summary of Outcomes Pre- and Post-PPS. For the five diseases combined, inhospital mortality was three percentage points lower post-PPS than pre-PPS ($p < 0.01$). This post-PPS improvement in mortality decreased to 1.0 percentage points by 30 days postadmission and was almost gone by 180 days postadmission.

For patients admitted to the hospital from home, for the five diseases combined, we found that 4 percent more patients discharged alive post-PPS were not discharged to home ($p < 0.05$). We found that 1 percent (0–3 percent depending on the state) more patients with a preadmission residence of home were in a nursing home six months following hospitalization post-PPS ($p > 0.05$). For the five diseases combined the proportion of patients with one or more readmissions within one year of the initial hospitalization was 3.0 percentage points lower post-PPS than pre-PPS ($p > 0.05$).

Effects of PPS Implementation

Post-PPS improvements in inhospital process of care (after accounting for changes in demographics, sickness at admission, and initial "do not resuscitate" orders) were associated with noticeable decreases in expected mortality for all five diseases (0.5 to 1.3 percentage points). Trend and patient analyses support the view that improvement in process was due to ongoing trends in medicine rather than to PPS.

In contrast, post-PPS increases in problems at discharge have risen in a way that seems associated with the implementation of PPS. These discharge problems have increased enough post-PPS to raise expected death rates by an amount that varies from a total of 0.2 percentage points for acute myocardial infarction patients to 0.9 percentage points for pneumonia patients. Furthermore, instability at discharge is increasing across both patient and hospital subgroups. Both results implicate PPS.

DISCUSSION

Before discussing the relationship between the introduction of PPS and changes in medical outcomes following hospitalization, it is important to place these results in context by noting the severe burden of illness carried by elderly patients hospitalized with one of the five conditions examined in this study. Within one month of admission, 16 percent of these patients have expired, with the death rate climbing to 29 percent within six months of admission. For our surgical condition—hip fracture—the six-month mortality rate is 16 percent, but for the other four medical conditions it is over 33 percent.

This burden of illness is also demonstrated by readmission rates. Of those patients who survived the initial hospitalization, more than half were readmitted in the year following their hospitalization. This fraction is highest for patients initially hospitalized with congestive heart failure (66 percent) and lowest for hip fracture patients (44 percent). In addition, across all our conditions, 25 percent of patients admitted from home and discharged alive are discharged to an institution. The corresponding figures for cerebrovascular accident and hip fracture patients are 41 percent and 52 percent, respectively.

Before and after the implementation of PPS, clinicians, patients, and families have feared, and in some instances have reported, disasters in outcomes of care that were thought to be related to the new financial incentives. We have measured outcomes pre- and post-PPS on a nationally representative sample of more than 14,000 patients who were hospitalized with one of five diseases that constitute 19 percent of Medicare admissions and 32 percent of deaths within 30 days of admission. In contrast to these fears and anecdotal reports, we find no significant increase post-PPS in mortality at 30 and 180 days posthospital admission, nor any significant increase in readmissions or prolonged nursing home stay. In fact, inhospital processes of care were noticeably better in 1985–1986 than in 1981–1982. We did find a significant increase in the fraction of patients discharged directly to an institution, but this does not appear to have resulted in a significant increase in nursing home stay at six months posthospitalization.

The main adverse change associated with PPS is a 20 percent rise in the rate with which patients are discharged from the hospital with instability. Total discharge problems, including instability and sickness at discharge and discharge to a nursing home, have increased enough post-PPS to raise death rates 0.2 to 0.9 percentage points.

Four caveats are worth bearing in mind when considering our results: (1) We studied only five diseases, albeit five important diseases in the Medicare cohort. (2) Our study design only allowed us to assess differences in quality of care once patients are hospitalized, so that, for example, we cannot comment on any changes in *access* to hospital care that PPS may have caused. (3) Our post-PPS payment data came from 1985–1986—a period in which the mechanism for determining the hospital's payment was still changing. The rates paid to hospitals at that time included a component based on historical charges during the cost-plus reimbursement era. In addition, the amount of reimbursement for a patient with a given diagnosis has changed since 1986, and hospital financial margins have diminished. (4) Although outcomes other than discharge instability have not worsened on average, some subgroups of patients may have suffered. Analyses to address this concern are ongoing.

Even with these caveats, two key policy conclusions appear clear: (1) At least through the middle of 1986, PPS did not interrupt an important long-term trend toward better processes of inhospital care—a trend that has led to somewhat lower death rates. (2) On the other hand, we believe that PPS has had a detrimental effect on patients' stability at discharge. These conclusions lead to two major policy recommendations: (1) To eliminate any existing problems with patient instability at discharge, physicians, hospitals, and PROs should undertake a more systematic assessment of the readiness of a patient to leave the hospital, so that patients are not discharged to home in a clinically unstable state. (2) To provide current information about the effects of Medicare's payment methods on quality of care, clinically detailed data that monitor sickness at admission, processes, discharge status, and outcomes should continue to be collected on a regular basis as long as prospective payment is in place.

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I. INTRODUCTION

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The health care costs of the Medicare program to the U.S. government have risen substantially over the last 25 years. Under the retrospective payment system in effect during Medicare's first two decades, costs rose at a rate much higher than background inflation. Between 1967 and 1984, for instance, Medicare expenditures for inpatient hospital care rose from about $3 billion to about $40 billion, and the growth was particularly rapid in the early 1980s. Medicare payments for hospital services increased 19 percent annually from 1979 to 1981, and hospital charges rose almost 16 percent in 1982, at a time when inflation was at about 5 percent (ProPac, 1986; DHHS, 1982).

In 1982, after review of the financial incentives associated with the retrospective payment system, Congress passed the Tax Equity and Fiscal Responsibility Act (TEFRA), which placed a prospective cap, beginning in October 1982, on annual operating revenues per inpatient Medicare case at each hospital. This was followed in October 1983 by the introduction of the present prospective payment system (PPS), in which hospitals are paid an amount based largely on flat rates per admission calculated for each of approximately 470 diagnosis related groups (DRGs). At the same time, the current system of professional review organization (PRO) monitoring of quality and appropriateness of care was established.

The new payment system has been somewhat successful at slowing the upward spiral of Medicare costs (Guterman et al., 1988). However, because prospective payment contains incentives to decrease lengths of stay and to substitute lower-cost services and procedures, patients, physicians, and policymakers are concerned that, despite the introduction of PRO monitoring, the quality of health care offered to Medicare patients may have declined under PPS. Since 1985 we have been conducting a large national study, funded by the Health Care Financing Administration (HCFA) of the Department of Health and Human Services, to investigate the effects of PPS on quality of care for hospitalized Medicare patients.

The goals of our study were (1) to assess the quality of inhospital care, for Medicare patients age 65 and over, before and after the implementation of PPS, and (2) to estimate the effects of the PPS intervention on quality of care, by comparing quality of care now with our best estimate of what it would have been in the absence of PPS. The remaining sections of this report present our findings. In this introductory section we provide an overview of our methods, offer a review of the recent literature on the effects of PPS, comment on the generalizability of our findings, mention some caveats in interpreting our results, and discuss a key design choice we faced and its implications for future data collection in quality of care assessment.

OVERVIEW OF OUR METHODS

We were not able to conduct a prospective controlled trial of the effects of PPS on quality of care, since virtually the entire country was put on prospective payment at about the same time. Instead, we designed a retrospective before-after study, in which we contrasted data on Medicare patients before and after 1983. We selected calendar years 1981 and 1982 as our pre-PPS study period and July 1985 to June 1986 as our post-PPS period, concentrating half our sampling in each of these periods.

To measure quality of care by looking for differences in quality of care across time periods or hospitals, we naturally examined patient outcomes such as mortality and hospital readmission rates. But patient sickness at admission also needs to be measured and adjusted for in making outcome comparisons, because patients' greater sickness would be enough to explain moderate differences in outcome even if nothing else changed. A third component—process (what clinicians do to patients)—is also important: If outcomes adjusted for sickness at admission change and we do not examine the processes of care, we cannot know why the change occurred and which aspects of care are now better and which are worse. Finally, because of PPS incentives to reduce lengths of stay, we also measured patient instability at discharge. We compared outcomes pre- and post-PPS after adjusting for sickness at admission; we measured the appropriateness of the processes of care given, through a series of explicit process criteria and through implicit review by expert clinicians; and we tried to establish process-outcome links, in which better care is shown to be associated with better outcomes, that would help explain any outcome differences we found. We also studied the relationship between sickness and instability at discharge and subsequent mortality.

To gather clinically detailed data on sickness at admission, inhospital processes and outcomes of care, and status at discharge, we used a stratified, multistage cluster sampling plan that selected 16,758 patients from 297 hospitals in 30 areas in five states. We linked these data with postdischarge outcome information on mortality, nursing home stays, and hospital readmissions drawn from files maintained by HCFA and fiscal intermediaries in our chosen states. The final sample was nationally representative with respect to six hospital-level factors—size, teaching status, ownership, percentages of Medicare and Medicaid patients, and size of the city in which the hospital is located—as well as patient demographics and mortality.

We based our evaluation of changes in quality of care on six diseases or conditions: congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture, and depression. We review below the logic behind our choice of these conditions and the implications of the selection process for the generalizability of our findings. In this report, however, we present results only from the first five of these conditions.

To identify comparable patients pre- and post-PPS, we defined each disease by ICD-9-CM codes so that any patient with one of these six conditions in either period as the principal reason for admission should have had one of these codes, even if there were coding changes over time. We then used strict clinically detailed inclusion criteria to select our sample of patients, excluding 24 percent of the records we examined in an attempt to achieve homogeneity within each disease or condition category.

We monitored the fieldwork closely to insure the accuracy of the data collection process. For explicit review, PROs in our chosen states selected nurses and medical records personnel experienced with clinical data to become data collectors; these persons underwent 17 days of training in the use of the disease-specific abstraction forms we designed specifically for the study. Each abstraction form contained approximately 700 items and took an average of 90 minutes to complete. We conducted interrater reliability studies, maintained a telephone hotline to resolve abstraction difficulties as they occurred, and had physicians and nurses review the completed abstraction forms for internal consistency. As a result of these monitoring efforts, 83 percent of our item-level kappa scores were at or above levels generally recognized as implying excellent reliability.

After the data were collected, we used regression methods to construct sickness-at-admission scales and to adjust outcomes for sickness at admission, and Likert scales and clinical judgment to construct explicit scales measuring the appropriateness of the processes of care and the level of instability at discharge. Some items that went into these scales were relevant to all patients, some only to subsets of patients depending upon their clinical needs. We concentrated on aspects of care for which the generally recognized standards of good clinical practice were both unambiguous and stable over time from 1981 to 1986.

We also developed a structured implicit review form; PRO clinicians used this instrument to give their expert judgments about the quality of care received by a 10 percent random subsample of the patients whose care we evaluated using explicit criteria. We used psychometric scaling and clinical judgment to build implicit process scales and regression to examine the relation between explicit and implicit process.

In every phase of the study we used a multidisciplinary approach. We drew on clinical expertise in general internal medicine, geriatrics, cardiology, pulmonary medicine, infectious diseases, neurology, orthopedics, and psychiatry from physicians in each of our five study states, including physicians from both urban and rural hospitals. This created a clinical perspective in the study that incorporated both academic and community-based views of medical care. This clinical perspective was complemented by expertise in statistics, psychometrics, economics, health policy, and evaluation sciences.

The remainder of this report gives additional details on our design, sampling, and fieldwork; the measurement of sickness at admission; the explicit measurement of process of care; the implicit measurement of process of care; patient status at discharge; patient outcomes before and after the introduction of PPS; and a summary of the effects of prospective payment on quality of care.

REVIEW OF THE LITERATURE ON PPS EFFECTS

When we began our study in 1985, little was known about the effects of PPS on quality of care. Since then, however, other investigators have obtained results that serve as context for this report. Here, we review the most recent contributions to this literature.

Using a sample of 646 U.S. nonfederal, short-term general hospitals from 1980 to 1985, DesHarnais et al. (1988) found that Medicare discharges and lengths of stay declined significantly after the introduction of PPS, whereas use of skilled nursing facilities and home health care after discharge increased post-PPS. Mayer-Oakes et al. (1988) studied patients in the intensive care units of three hospitals before and after PPS. They found a 31 percent decrease in the number of intensive care unit beds but no changes in patient illness or treatment intensity after PPS was implemented. They found a reduction in lengths of stay, both for the overall hospitalization and for the use of the intensive care unit. Despite the reductions in lengths of stay, they found no significant changes in mortality inhospital or at six months after hospitalization. This study also confirmed the work of DesHarnais et al. in identifying a higher percentage of patients who were institutionalized after PPS. More recently, Sager et al. (1987, 1989) used age-specific national mortality data from 1981 through 1985 to report changes in the location of death after PPS from the acute care hospital setting to nursing homes. Guterman et al. (1988) found a reduction in the number of Medicare short-stay hospital admissions, a reduction in lengths of stay, and an increase in number of discharges to skilled nursing facilities using HCFA's Medicare Statistical System as a data source.

Fitzgerald et al. (1987, 1988) found the most striking differences in outcomes after PPS, in their analyses of discharge disposition and prolonged nursing home stay for hip fracture patients in two large hospitals before and after PPS. They reported (1988) that a reduction in the number of physical therapy sessions given to patients after PPS accompanied the reduction in lengths of stay. Most important, they found an increase from 38 percent to 60 percent in the proportion of patients discharged to a nursing home, and an increase from 9 percent to 33 percent in the proportion of patients with continued nursing home care at one year after discharge. These results, taken from events at a single hospital, are in contrast to those of Palmer et al. (1989), who found no change in either the proportion of hip fracture patients discharged to a nursing home or the proportion in a nursing home at six months. However, the Palmer et al. study also used data from a single hospital, albeit one with quite different characteristics than the Fitzgerald et al. hospital. Gerety et al. (1989) studied hip fracture patients in a tertiary care setting and found shorter lengths of stay and decreased functional status at discharge post-PPS. Their assessment of outcomes at one year after hospitalization showed no difference pre- and post-PPS in the fraction of institutionalized patients. These results emphasize the need for generalizable evidence on the effects of PPS on quality of care. We have tried to provide such evidence in this report.

GENERALIZABILITY OF OUR FINDINGS

In choosing six conditions for study, we developed the following criteria characterizing desirable conditions: high prevalence in the Medicare population; high mortality, so that patterns of care leading to preventable death might be evident; well-defined diagnostic criteria that are readily available from data in the medical record; high likelihood of a strong process-outcome link, so that any changes in outcome have a better chance of being correctly traced back to changes in process; and relative stability of consensus on what constitutes good care across the entire period from 1981 to 1986 (Kahn et al., 1988a).

In selecting these study conditions, we recognized that it would be ideal to study conditions with stable diagnostic and therapeutic modalities across the study periods. We attempted to select such conditions and avoided including for study several interesting conditions because of apparent changes in medical practice over time. However, it is impossible to state for a certain disease that no changes in diagnoses or therapies have ensued during the period from 1981 to 1986, or during any five-year period. The diseases we selected, however, were selected, among other reasons, for relative stability in process over time. Even for acute myocardial infarction, the major new interventional strategies were not widely diffused by June 1986. This is seen in Table 1.1 where we have displayed use rates for four "new" interventions.

Of these interventions, the only one with proven efficacy for reducing mortality in the patient with acute myocardial infarction is streptokinase. Although the GISSI trial (1987) showed a reduction in mortality at one year for patients overall with acute myocardial infarctions (17.2 percent for patients treated with streptokinase and 19.0 percent for control

Table 1.1

USE OF NEWER TECHNOLOGIES FOR PATIENTS WITH ACUTE MYOCARDIAL INFARCTION PRE- AND POST-PPS

Technology	Pre-PPS (n=1,416)	Post-PPS (n=1,437)	Pre- and Post-PPS Combined (n=2,853)
Coronary artery bypass surgery	0.8	2.7	1.8
Coronary angiography	2.7	7.8	5.3
Angioplasty	0.1	2.2	1.2
Streptokinase (includes both intravenous and intracoronary use)	2.3	5.5	3.8

patients, p = 0.008), there was no significant difference in one-year mortality for patients 65 years old or older. It would be difficult to attribute changes in mortality for patients with myocardial infarction post-PPS compared with pre-PPS to the use of streptokinase both because of the low frequency of its use in both time periods (though its use increased post-PPS) and because the patients in our study were all 65 years old or older.

To be conservative, we included process criteria in the study only if there was general agreement among our physician expert consultants that a particular process measure was equally relevant in 1986 as in 1981. In the event that an important new technology was introduced and we thought it was important to include the use of that technology in our process measures, the process criteria were developed in a way that would avoid a time-period bias. For example, in developing the process criteria for cerebrovascular accident, we recognized that in 1986 many institutions, especially academic institutions, believed it was standard practice to image the brain of very sick stroke patients with a CAT scan. However, this clearly was not standard practice in 1981. In the early 1980s, however, it was standard practice to image the brain of very sick stroke patients with a brain scan or electroencephalogram (EEG), or to perform a lumbar puncture or carotid angiography. Thus, our process criteria state: "If the patient with cerebrovascular accident shows posturing, no response to pain, or coma, then do any of the following: CAT scan of the brain, carotid angiography, brain scan, electroencephalogram, or a lumbar puncture." This way, credit is assigned in the scoring of the process criteria for use of any of the modalities that were considered standard diagnostic measures for very sick stroke patients during the entire period from 1981–1986.

A second example of how we used a new technology to study process, but avoided a time-period bias, is with our study of the use of streptokinase for patients with acute myocardial infarction. We do not assign or penalize for use of streptokinase in either the pre- or the post-PPS periods. However, we do use the following process criteria: "If the patient is given streptokinase, then documentation should be made in the medical record of the presence or absence of a bleeding disorder." (Streptokinase is contraindicated in patients with bleeding disorders.) In this example, the use of streptokinase does not contribute to a higher or lower process score. However, the process criteria state that if streptokinase is used, it should be used properly (only after documentation of no bleeding disorder) regardless of use in the pre- or post-PPS period.

Another process criteria states, "If the patient is given streptokinase, then the streptokinase should be started within six hours of the time symptoms were first noted." Again, process credit or debit is not assigned for use of streptokinase but for proper use in the event that the drug is used.

The other principle that guided our selection of diseases was the desire to stratify on how the disease was primarily treated, across the categories medical, surgical, and psychiatric. In this way we were led to four medical conditions (congestive heart failure, acute myocardial infarction, pneumonia, and cerebrovascular accident), one surgical condition (hip fracture), and one psychiatric condition (depression). In the sections that follow we present both disease-specific findings and results obtained by aggregating across our five nonpsychiatric diseases.

By virtue of the representativeness of our patient samples, our results generalize directly to the population of all Medicare patients with one of these five nonpsychiatric diseases—a population that included 18 percent of all Medicare admissions and 32 percent of all deaths within 30 days of admission in fiscal 1986 (HCFA, 1986a). But do our results generalize outward to the population of Medicare patients with other diseases, and thus to the entire Medicare cohort?

Three general remarks can be made in answering this question. First, in searching for process-outcome links, we have focused mainly on connections between process and mortality. We cannot comment on changes in quality of care for patients with terminal conditions such as end-stage cancer, where no change in process can lead to a better mortality outcome given the present state of medical knowledge. For such patients, quality of care would be defined by such factors as functional status and the quality of the dying experience, and we did not measure these aspects of care. Second, our results probably generalize more readily to other medical conditions than to other surgical and psychiatric diseases. However, for categories of process that show consistent patterns of change across all of our conditions, it is hard to imagine how such change would be concentrated only in those conditions, when the same components of care (e.g., thoroughness of nursing services, appropriateness of ordering of laboratory tests, and completeness of physician history and physical examinations) are an integral part of care for other conditions as well.

Third, our selection of diseases makes possible a kind of upper bounding or a fortiori argument of the following form: By concentrating on conditions with high mortality and likely strong process-outcome links, we chose diseases for which it seemed that, if quality of care has declined under PPS, this decline would likely manifest itself in process and outcome changes in patients with these diseases. Therefore, if we do not see a large decline, the overall detrimental effects of PPS aggregated across all Medicare patients cannot be very large. For aspects of care in which we do see a decline, this argument is of no help in precisely estimating its overall magnitude for all Medicare patients, but where we do not see a decline, we will have learned something about the likely effects of PPS on the entire Medicare cohort.

CAVEATS ON THE INTERPRETATION OF OUR RESULTS

In addition to the above remarks about generalizing outward from the diseases we selected, three other major caveats are worth bearing in mind.

Our design involves a direct comparison between the quality of care given in 1981–1982 and in 1985–1986. We are thus able to fully demonstrate that any changes in quality we find are associated with the introduction of PPS, but definitively identifying which of those changes were caused by PPS is harder, since other aspects of medical care besides PPS may also have changed from 1981 to 1986 (Vladeck, 1988). We have attempted to deal with this by measuring quality of care at multiple time points in both the pre- and post-PPS periods, so that secular trends in medicine that were in place before PPS was implemented may be at least crudely estimated and removed. Our approach in this report is to first present straightforward comparisons of the pre- and post-PPS periods and to sort out issues of trend and causality in the last section.

We studied quality of care only for hospitalized patients, and we did not examine questions of access to that care. We cannot address whether PPS has made it harder or easier for certain types of patients to obtain high-quality care, an important part of the total PPS policy picture.

Finally, our post-PPS data are from 1985 and 1986. Although all hospitals had changed to a prospective payment system by 1985, payments were still determined in part by the hospital's own costs through 1986. During 1985 and 1986 most hospitals were still profiting from PPS. Since that time PPS payments have been tightened, and yearly Medicare payment increases to hospitals are no longer keeping up with the inflation rate (Iglehard, 1986; ProPac, 1988). On the other hand, changes in lengths of stay associated with the introduction of PPS appear in recent years to have stabilized and have not continued to decline (Witsberger and Kominsky, 1990). Our results may be suggestive of the state of affairs in 1989, but it seems wise to continue to collect clinically detailed data to monitor sickness at admission, processes, and outcomes on a regular basis as long as prospective payment is in place.

DISCUSSION

At the beginning of our study, we faced a key design choice that has implications for future data collection in quality of care monitoring: Should quality of care studies be based on detailed clinical review of medical records, or on administrative data gathered routinely, or on both? In these final paragraphs, we lay out the pros and cons of each approach and discuss the reasoning behind the choice we made in our study.

A good example of a large administrative database is HCFA's MedPAR file (HCFA, 1986b), which contains extensive billing information, but only a minor amount of clinical detail, on every Medicare hospitalization. Since 1987 HCFA has linked this administrative dataset to Social Security death files and reported hospital-level mortality rates (HCFA, 1987). The cost per case of clinically detailed review of medical records is much higher than the corresponding cost of obtaining MedPAR information linked with mortality outcomes, so that, for the same amount of money that it would take to examine MedPAR data on the entire Medicare population, one could afford to subject only a sample from this population to clinical review.

Constraints imposed by the cost of detailed medical record review may limit in three ways the numbers and kinds of patients studied clinically. As we detail in Sec. II, the only cost-feasible way to select a nationally representative sample of hospitalized patients for extensive medical record review is through multistage cluster sampling, for instance, by choosing samples of states, geographic areas within states, hospitals within areas, and patients within hospitals. In addition, to make statements about quality of care over a multiple-year period, it may be necessary for cost reasons to further restrict sampling with the medical-record-based approach to a subset of the years of interest. Finally, we have previously argued that evaluating the appropriateness of medical care is better done disease by disease, so that with a limited budget one must also choose a sample of diseases on which to concentrate quality of care monitoring (Kahn et al., 1988a).

The central drawback to the medical-record-based approach is thus that its findings will necessarily be based upon a sample of patients, rather than upon all patients of interest to the study. In addition, the operational complexities of using a medical-record-based approach cause a longer delay in making the data available for use than is seen when using administrative data. The central advantage to this approach is the rich clinical detail one can collect on sickness at admission, appropriateness of the processes of care delivered, instability at discharge, and outcomes. Table 1.2 summarizes the advantages and disadvantages of the two approaches. Other researchers (Roos et al., 1987) have come to similar views. In our study we chose the medical-record-based approach.

We encourage readers of this report both to examine our findings critically and to reflect on where to go from here in data collection and analysis for quality of care assessment and assurance among Medicare and other patients. What combination of clinical detail and administrative data would lead to the most cost-effective approach to monitoring quality of care in U.S. hospitals in the 1990s, as the effects of PPS and other cost-containment measures become stronger? Should HCFA require hospitals to report clinical information routinely, along with billing data? If so, which clinical data? If not, how well can high- and low-quality facilities be identified on the basis only of administrative information linked with mortality files? Answers to these important questions are not yet known.

Table 1.2

ADVANTAGES AND DISADVANTAGES OF QUALITY OF CARE STUDIES BASED ON DETAILED MEDICAL RECORD REVIEW COMPARED WITH THOSE USING ADMINISTRATIVE DATA

Clinically Detailed Medical-Record-Based Studies	Studies Based on Administrative Data	Which Is Better?
Limited number of diseases	All diseases	Administrative
Limited number of states and hospitals	All states and hospitals	Administrative
Limited time period	All times	Administrative
Moderate sample size and national representativeness	The entire national dataset	Administrative
Clinically rich	Clinically poor	Medical-record-based
Sickness at admission	Limited	Medical-record-based
Outcomes	Mortality only	Medical-record-based
Appropriateness of processes of care	Almost nothing	Medical-record-based
Instability at discharge	Nothing	Medical-record-based
Long delay in making results available for publication	Shorter delay in making results available for publication	Administrative

II. DESIGN, SAMPLING, AND FIELDWORK

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METHODS

Choice of Treatment, Control Groups, and Study Years

PPS was not introduced in 1983 as a controlled experiment. Instead, before October 1983 hospitals were reimbursed for treating Medicare patients under the old retrospective payment system, and from October 1983 to September 1984 nearly all acute care general hospitals were phased into prospective reimbursement. The exceptions were hospitals in the so-called waiver states—Maryland, Massachusetts, New Jersey, and New York—where reimbursement alternatives to the PPS system were used until 1986.

Because PPS was introduced in this nonexperimental way, a prospective controlled trial evaluating its effects on quality of care was not possible, and we instead designed a retrospective observational study. A comparison of the pre- and post-PPS periods, in which data on Medicare patients before and after 1983 are contrasted, is central to any such study. Designs including only data-gathering of this type are straightforward but have a potential confounding factor: The effects of PPS will be confounded with any secular trends over time in the quality of care, unless such secular trends may be estimated and removed. There are two main ways to do this: either (a) estimate the trends based only on data from Medicare patients, or (b) obtain information from both periods in parallel on a control group of patients unaffected by PPS and use the trends evident in the control group as a proxy for what the Medicare trends would have been in the absence of PPS.

Both of these options have strengths and weaknesses. With option (a) all of one's detailed data-gathering is concentrated in the Medicare population, which provides a more accurate look at what actually happened to Medicare patients pre- and post-PPS; but some form of extrapolation of pre-PPS trends is needed to impute what would have been observed post-PPS if PPS had not been implemented. With option (b), provided the control patients are truly unaffected by PPS, and what happens to them is a good proxy for what would have happened to Medicare patients in the absence of PPS, no extrapolation is needed, because contemporaneous control information is gathered directly in the post-PPS period; but a group providing such a proxy may be difficult to find, and detailed data-gathering on the control group diminishes the Medicare sample sizes.

In considering option (b) we examined three sources of non-PPS data: patients treated in the waiver states, non-Medicare patients (e.g., those 55–64 years old), and patients from another country (e.g., Canada). The waiver states option was inadequate because the reimbursement programs in those states did not represent an absence of PPS but merely one or another variation on PPS. The non-Medicare option was problematic, because changes in hospital behavior induced by PPS might affect these patients also. Finally, studying changes in quality of care over time in another country was also problematic, because the health care systems in other countries are probably too different to use trends in their quality of care pre- and post-PPS as stand-ins for what the U.S. experience would have been if PPS had not been implemented. Nevertheless, if sufficient funding had been available, we would have included a sample of the Canadian elderly population or the U.S. 55–64 year-old cohort as a control group.

In the end, however, after consultation with an expert panel, we chose a pre-post design involving only Medicare patients, with multiple time points and appeals to national secondary data to estimate the secular trend.

We chose as our pre-PPS sampling window the period from January 1, 1981, to December 31, 1982, and as post-PPS window the period from July 1, 1985, to June 30, 1986. This pre-PPS window was the furthest back in time we could go and still be assured of high availability and quality of medical records data, and our chosen post-PPS window was the furthest forward we could go given the lag time in availability of postdischarge data crucial to our evaluation of quality. Our design concentrated 50 percent of the sampling in each of the pre- and post-PPS periods, as follows: 20 percent in 1981, 30 percent in 1982, and 25 percent in each of 1985 and 1986.

Our design was longitudinal at the hospital level and cross-sectional at the patient level: We gathered data at each sampled hospital in all study years, with different patient cohorts sampled in each time period within the chosen hospitals. This hospital-level pairing increased the accuracy of the pre-post comparison by holding the hospital factor constant.

We have elsewhere advocated the measurement of quality of care in a disease-specific way (Kahn et al., 1988a). However, it is expensive to develop clinically valid disease-specific abstraction forms that can measure outcomes, sickness at admission, and appropriateness of processes of care. With a fixed total budget, this places a constraint on the total number of diseases sampled. We stratified the universe of diseases to which Medicare patients are susceptible into three groups—medical, surgical, and psychiatric—and selected six diseases for study: four medical, one surgical, and one psychiatric. The conditions we selected have both high frequency and high death rates in the Medicare population: Together our six diseases accounted for 18 percent of all Medicare admissions and 32 percent of all Medicare deaths within 30 days of admission in fiscal 1986. (See App. A for further discussion of disease selection and for a discussion of how our sampling plan changed to accommodate the study of patients with depression.) We discuss the extent to which our findings from these six diseases generalize outward to other Medicare patients in Sec. I.

Summary of Sampling Plan

We used a stratified, multistage cluster sampling plan with four levels of sampling hierarchy: states, areas within states, hospitals within areas, and patients within hospitals. We oversampled hospitals treating many Medicare patients and chose approximately the same number of patients from each hospital in a way that produced patient-level national representativeness. In our sampling design we chose five states, 4–8 areas per state for a total of 30 areas nationwide, 6–18 hospitals per area for a total of approximately 60 hospitals per state and 300 hospitals overall, and about 57 patients per hospital for a total of approximately 17,000 patients.

Choice of States. We selected our final states purposively, subject to eligibility criteria and stratification goals. Eligibility considerations excluded (a) the waiver states and (b) states with either too few hospitals or a mixture of hospitals that was either too urban or too rural. The main stratification goal in the choice of states was geographic diversity, with one state from each region of the country. Our final sample included California, Texas, Indiana, Pennsylvania, and Florida (see App. A).

Choice of Areas. We had to choose between two options for abstraction of data from medical records in this study: either (1) photocopying the chosen records and sending the copies to a central location in each state for abstraction, or (2) having data collectors go to the chosen hospitals and gather the data in person. We piloted both methods and discovered that the photocopy quality of microfilmed records, which made up a nontrivial portion of the pre-PPS sample, was too poor to permit that option. Given the resulting cost restrictions on data collector travel, the only feasible sampling plan involved dividing the chosen states into geographic areas and clustering the chosen hospitals in a sample of these areas.

We used geographic diversity within state and six hospital-level factors as stratification variables in making our final choice: city size, percentages of Medicare and Medicaid patients, hospital size, teaching status, and hospital ownership (e.g., proprietary compared with nonprofit). We considered a large number of designs, each with a total of 20–30 areas, by conducting a computer-aided search among all possible choices of 4–8 areas in each state. Our final choice (1) had substantial geographic and urban-rural diversity within each state; (2) permitted oversampling of large hospitals and facilities with a high percentage of poor patients (as indicated by Medicaid status), particularly those that might be called "classic city-county" hospitals (city or county teaching facilities with inner-city locations serving a large fraction of the indigent), so that we might learn more about the effects of PPS on poor patients; and (3) permitted the selection of hospitals that were nationally representative with respect to city size, percentage of Medicare patients, teaching status, and ownership.

Choice of Hospitals. We based the hospital-level sampling frame on the 1984 HCFA Provider of Services file (HCFA, 1986b). We used three eligibility criteria at the hospital level. First, we restricted sampling to short-term acute care facilities, thereby excluding veterans', military, and psychiatric hospitals. Second, we also restricted attention to hospitals that were in existence during the entire period from 1981 to 1986. Third, a small number of hospitals in our chosen states had 15 or fewer estimated total patients per year with one or more of our six study diseases (based on HCFA's 1984 MedPAR file) and were judged to be too small.

The final hospitals were chosen by defining a 4x4 stratification grid (Table 2.1) indexed by hospital size, city size, and hospital poverty status. We defined as high-poverty hospitals those whose percentage of Medicaid patients was at or above the 90th percentile of the percentage of Medicaid patients in the state in which the hospital was located. The goal was representativeness with respect to hospital size and city size, and a double oversampling of both high-poverty hospitals and classic city-county facilities. Hospitals were then chosen by a restricted randomization procedure that attempted to maximize representativeness with respect to ownership, teaching intensity, and percentage of Medicare patients, while varying the number of hospitals per area from 6 to 18 in such a way that the stratification targets in Table 2.1 were achieved. In this manner 300 hospitals were chosen.

Almost all of the 300 selected hospitals agreed to participate in the study. Five hospitals refused and were replaced by hospitals in the same area with similar characteristics. Three other hospitals also refused to participate and were not replaced, resulting in a final sample of 297 hospitals and a hospital-level participation rate of 97 percent (297/305).

Table 2.1

NATIONAL COMPARED WITH SAMPLE BREAKDOWN IN THE 4x4 STRATIFICATION GRID[a]

	Rural		Urban		
Hospital Size[b]	Poor	Not Poor	Poor	Not Poor	Total
Very small	0.8	5.0	0.5	4.1	10
	0.9	5.6	1.8	2.2	11
	1.0	4.5	0.4	3.5	9
Small	0.8	7.5	1.2	9.4	19
	1.7	7.8	5.8	6.2	21
	1.2	7.7	1.1	9.3	19
Medium	0.6	5.8	4.4	41	51
	0.0	5.0	7.3	37	49
	0.0	6.1	4.5	41	52
Large	0.0	0.3	1.8	18	20
	0.0	0.0	1.6	18	19
	0.0	0.0	1.8	18	20
Total	2.1	19	7.9	73	100
	2.6	18	16.5	63	100
	2.2	18	7.7	72	100

[a] The top figure in each cell in this table is the national prevalence of patients at hospitals of the indicated type; the middle figure is the raw, unweighted sample prevalence; and the bottom is the reweighted sample prevalence using weights chosen to approximately reproduce the national prevalences. The national figures were arrived at by weighting hospital-level data from the 1984 HCFA Provider of Services file by each hospital's number of certified beds, adjusted for its Medicare volume and occupancy rate. Thus the top number in the upper left-hand corner of the table, for instance, means that roughly 0.8 percent of the nation's Medicare patients are treated in very small rural poor hospitals, not that 0.8 percent of the nation's hospitals are very small, rural and poor. The cutoffs for hospital size are as follows: very small (adjusted beds fewer than 22); small (between 23 and 49); medium (between 50 and 154); and large (more than 154).

[b] Number of beds adjusted for Medicare volume. Adjusted beds = the number of certified beds, multiplied by the hospital's percentage of Medicare patients.

Choice of Patients. We based the patient-level sampling frame on lists, generated by the chosen hospitals, of patients hospitalized in each study year with one of the study diseases, as indicated by ICD-9-CM codes (Table 2.2). Twelve hospitals were unable to provide such lists, so we built the patient sampling frames for those hospitals from HCFA's MedPAR file. We chose simple random samples of patients in the cells of a 3x6 grid indexed by study period (1981, 1982, 1985–1986) and disease. The goal was balance across all diseases, with nine or ten patients chosen from each disease category in each hospital, distributed within each disease across study periods in the approximate proportions 20 percent (1981), 30 percent (1982), and 50 percent (1985–1986). Our final sample had 51–62 patients per hospital (except for 12 small hospitals, where the number of patients per hospital ranged from 17 to 50), with an average of approximately 57 patients per hospital and a total of 16,758 patients, slightly fewer than our target of 17,000.

Table 2.2

ICD-9-CM CODES DEFINING THE SIX STUDY DISEASES

Disease	ICD-9-CM Codes
Congestive heart failure	428.xx[a]
Acute myocardial infarction	410.xx
Pneumonia	480.9x
	481.xx
	482.xx
	483.xx
	485.xx
	486.xx
	487.0x
	507.0x
	510.xx
	511.1x
	513.0x
	799.1x
Cerebrovascular accident	431.xx
	434.xx
	436.xx
Hip fracture	820.0x[b]
	820.2x
	820.8x
Depression	296.2x
	296.3x
	298.0x
	300.4x
	309.0x
	309.1x
	311.xx

[a] x = any value 0 to 9 or no value.
[b] Except 820.01.

To meet our goal of 57 patients per hospital we had to examine a somewhat larger number of records, because some records were unavailable for study and others did not meet our clinical inclusion criteria (see below). In total, 22,795 records were requested from the participating hospitals.

Hospitals were able to find the requested medical records in almost all cases. Of the 22,795 medical records requested, 870 (3.8 percent of the requested records) were not available for review, leaving 21,925 total records reviewed. Table 2.3 summarizes the reasons given for unavailability. As expected, the number of unavailable records was higher in 1981 (6.6 percent of those requested) and 1982 (5.0 percent) than in 1985–1986 (1.7 percent). The number of unavailable records was sufficiently small that any resulting bias would be too small to significantly change the study's major findings.

Data Collector Training, Abstraction, and Monitoring

Nurses and medical records personnel experienced with clinical data were selected by the PROs in the chosen states to become data collectors. After demonstrating adequate

Table 2.3

REASONS WHY SOME MEDICAL RECORDS WERE UNAVAILABLE, BY YEAR

Reason	1981	1982	1985–1986	Total
A. Couldn't find patient with that admission/disease/timeframe. Patient's record was pulled, but the requested admission could not be found; or patient's record was not pulled because the requested admission was not found on the indexes; or mistaken medical record number was recorded and record pulled was for the wrong patient, e.g., one who was under 65 years of age or had the wrong diagnosis; or patient's record was located on microfilm/microfiche, but the requested admission was not in the record; or the medical record number was not a valid number for the time frame requested or no patient has the number; or requested medical record number was outpatient only.	78	59	43	180
B. Record sent out to be microfiched. Record not available because it was being microfiched.	21	20	5	46
C. Record cannot be found. Medical records department was unable to locate the chart (used this code when more complete description of the location problem was not given or was not understandable); or indexes indicated that record was stored off site but the record could not be found or could not be retrieved; or patient died in the hospital and the chart, which should have been archived according to hospital policy, could not be located; or record was pulled for RAND study, but no one could find it when review coordinator arrived to do the abstractions.	162	184	97	443
D. Only the emergency room report could be found. Patient died shortly after admission. Only the emergency room report could be found.	0	0	1	1
E. Problem with numbering system on records or on microfiche. Hospital changed system of numbering records and could not locate some 1981 and 1982 records without the patients' names; or unable to locate because of problem with numbering on microfiche jacket.	30	33	0	63
F. Record was in use/out for other review. Board of Health Review Team has the record; or patient in the hospital and/or the chart was in use when the review coordinator needed it; or record was impounded by court during litigation and never returned.	2	3	6	11
G. Record found too late. Record found after form was filled out or after review coordinator completed quota for the disease.	15	24	15	54
H. Parts of record missing or unreadable. Microfilm roll was located but would not feed into the reader/printer; or chart was pulled but parts needed for the study were missing.	2	9	1	12
I. Record shredded in error. Chart was shredded by mistake.	3	0	0	3
J. MedPAR information not sufficient to locate the record. MedPAR information was not sufficient to locate the chart.	2	3	0	5
K. Shredded after 5 years by policy/confiscated in takeover. Chart was destroyed per hospital policy of shredding after 5 years; or record was confiscated in hospital takeover.	2	5	1	8
L. Patient and admission same as one already pulled. Patient and admission were the same as one already pulled for this hospital/disease.	2	6	2	10
M. No documentation received on why record was unavailable.	12	7	15	34
Total requested records	5,012	6,999	10,784	22,795
Total unavailable records	331	353	186	870
Percent unavailable records	6.6	5.0	1.7	3.8
Total reviewed records	4,681	6,646	10,598	21,925

skills, 52 data collectors participated in training that lasted 17 days and covered all six diseases, with at least two days focused exclusively on the study of each disease.

During the period of data collection, we monitored abstractors with a series of interrater reliability studies[1] and gave feedback to data collectors who were identified as having problems. A project manager who was familiar with the hospital in which the abstraction took place supervised the work. In addition, each completed abstraction form was reviewed by both a physician and a nurse for an average of 30 minutes per record, to assess internal consistency and to assure that coding was consistent with supporting clinical data. Certain types of clinical information from the medical record (e.g., the exact words characterizing a patient's stroke if one occurred) were written verbatim into the abstraction form, and specified pieces of data (e.g., chest X-ray reports, admission histories and physicals, and discharge summaries) were photocopied and attached to the form. Discrepancies that could not be resolved during the review process were returned for reabstraction. Physicians interpreted photocopies of X-ray reports and some EKG tracings and reports.

The research team visited data collectors in the field at least once during the data collection period. A supervisory project manager spoke with the research team in each state at least weekly. In addition, we invited data collectors and project managers to call a RAND telephone hotline and speak with a physician about any questions that might arise in the field as they used the abstraction form. Some data collectors used the phone calls to clarify the meaning of an item in the abstraction form or guidelines. Others called to discuss the best means for abstracting data given a patient situation that had not been previously anticipated.

To maintain confidentiality of hospitals, patients, and physicians, coded identifiers were assigned to hospitals and patients. No identifying information about physicians was obtained.

Each disease-specific abstraction form (Kahn et al., 1988b; Kosecoff et al., 1988; Roth et al., 1988; Rubenstein et al., 1988; Sherwood et al., 1988; and Wells et al., 1988) contained approximately 700 items grouped into five categories: inclusion criteria, demographics and sickness at admission, explicit information about the processes of care given to the patient, patient outcomes, and patient status at discharge. We discuss the inclusion criteria below; more details about data elements in the other four categories can be found in other sections of this report. The abstraction forms took an average of 90 minutes per record to complete. (See App. A for further discussion of instrument development and data collector performance.)

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[1] By comparing national and sample patient-level prevalences in cross-tabulations indexed by hospital size, city size, poverty status, teaching intensity, hospital ownership, and percentages of Medicare and Medicaid patients, we created weights that compensated for our oversampling of high-poverty and classic city-county facilities and for small unintentional discrepancies between the national and sample Medicare cohorts. Table 2.1 presents unweighted and weighted sample prevalences in the 4x4 stratification grid used to choose the hospitals. The weights were computed by forming ratios of national to sample counts in Table 2.1 and modifying the resulting values slightly to improve representativeness, after reweighting, on the other variables of interest (teaching intensity, hospital ownership, and percentage of Medicare patients) not factored into Table 2.1.

We chose a sample of the items on our abstraction forms for interrater reliability studies. Table 2.6, below, summarizes our findings with percentage agreement and kappa statistics (AHA, 1984). A few kappa values were negative, even though the corresponding percentage agreement values were high. This occurred mainly when there was so little variation in response to an item across data collectors that kappa was almost undefined (see footnote d in Table 2.6). Such values were truncated to zero in the table.

Inclusion Criteria

We used inclusion criteria to assure a homogeneous group of patients with the chosen diseases in the pre- and post-PPS periods. To be included in one of our disease-specific samples, patients had to be at least 65 years of age, admitted during a study year, and hospitalized for the indicated disease. Patients with the study disease as a complication of hospitalization, rather than as a reason for admission, were not eligible for the sample. Except for depression, we did not include patients who were transferred from another acute care general hospital, because we did not have access to the medical record from the initial hospital stay. We also excluded patients with major competing conditions (e.g., end-stage cancer in a patient with congestive heart failure) that were likely to determine process and outcome for the patient regardless of the presence of the study disease.

Of the 21,925 reviewed records, 24 percent (5,167) were excluded (Table 2.4). The fraction of records excluded in the post-PPS period (21 percent) was significantly lower than the fraction excluded in the pre-PPS period (26 percent). Table 2.5 shows the most frequent causes of exclusion—clinically detailed review of the medical record showed that the patient did not have symptoms or signs of the disease suggested by the hospitals' assignment of ICD-9-CM codes. For example, 17 percent of the patients with congestive heart failure coded on their medical records did not have symptoms of congestive heart failure at admission, i.e., did not have either chest X-ray evidence for heart failure or leg edema at admission. (See App. A for further details about disease-specific inclusion and exclusion criteria and for a discussion of acute care hospital transfer and PPS effect.)

Secondary Data Collection

In addition to the clinical primary data described above, we also collected secondary data of two types: (1) information about postdischarge outcomes that we merged with the records in our primary database, to examine the effects of PPS on outcomes during the year following hospitalization; and (2) national data on mortality trends in our study diseases over the period from 1980 to 1986, with which to compare our sample data for validation purposes.

Table 2.4

PERCENTAGE OF RECORDS EXCLUDED, BY DISEASE AND TIME PERIOD[a]

Disease	1981	1982	1985–1986	Total
Congestive heart failure	29.8	28.4	19.7	24.5
Acute myocardial infarction	18.7	16.7	14.8	16.2
Pneumonia	39.3	38.1	35.9	37.3
Cardiovascular accident	22.4	21.8	13.1	17.7
Hip fracture	21.8	18.3	14.9	17.4
Depression	21.7	25.9	24.2	24.4
Total number excluded	1,266 (26.2%)	1,677 (25.5%)	2,244 (21.2%)	5,187 (23.6%)
Total number included	3,455	4,949	8,354	16,758
Total number excluded + included	4,721	6,626	10,598	21,925

[a] The percentages given are of the form (number of excluded records/number of included + excluded records).

Table 2.5

FREQUENT REASONS FOR RECORD EXCLUSION, BY DISEASE
(In percent)

Reason	Congestive Heart Failure	Acute Myocardial Infarction	Pneumonia	Cerebro-vascular Accident	Hip Fracture	Depres-sion	Five Diseases
Not hospitalized during study year	0.3	0.4	0.2	0.3	0.3	0.2	0.3
No eligible ICD-9-CM code	1.0	1.5	1.6	1.2	1.5	2.5	1.6
Age < 65	0.2	0.3	0.5	0.3	0.1	0.7	0.4
Transferred from another acute care hospital	1.8	4.1	1.8	3.3	2.2	ND	2.6
No symptoms/signs of disease at admission	16.8	6.5	27.5	11.0	2.2	10.9	12.5
Acute myocardial infarction at admission	0.7	ND	0.2	0.3	0.2	ND	0.4
Other competing conditions[a]	1.3	2.2	3.6	0.6	10.3	6.4	4.1
Poor prognosis or active cancer	1.8	ND	ND	ND	ND	1.2	1.5
Total number excluded	916	550	1,632	608	581	880	5,167
Total number included	2,824	2,853	2,749	2,824	2,762	2,746	16,758
Total number excluded + included	3,740	3,403	4,381	3,432	3,343	3,626	21,925

NOTE: ND signifies no data. The disease-specific abstraction form did not specify this as an exclusion criterion and therefore no data were collected on this item.

[a] Other competing conditions included important clinical problems present at admission that were likely to influence process or outcome in ways not seen in patients without these conditions. For example, the presence of bilateral hip fracture or multiple trauma were exclusion criteria for hip fracture patients.

We compiled three kinds of postdischarge outcome information: mortality, hospital readmissions, and nursing home stays. To obtain postdischarge mortality data, we used patients' last names, first names, dates of birth, and Health Insurance Claim (HIC) numbers from the medical record to match our sampled patients with the corresponding records in HCFA's Health Insurance Master (HIM) file (HCFA, 1986b). We were able to obtain accurately merged postdischarge mortality information on 92 percent of our sample. We give additional details on the merging of our primary data with postdischarge databases in Sec. VII.

To validate our sampling with respect to mortality, we obtained data from HCFA's MedPAR file on all patients hospitalized with the five selected diseases (n = 2,062,610) in the 27-quarter period from January 1980 to September 1986. Variables we extracted from the MedPAR file included death status within 30 days of admission; gender; age (65–69; 70–74; 75–79; 80–84; 85–89; and 90+); and DRG. We established a correspondence between our ICD-9-CM-based disease definitions (Table 2.2) and DRGs and used these data to calculate age/sex-specific, and age/sex-adjusted, 30-day death rates for each disease, and in the aggregate across diseases, in each of the 27 quarters.

We then used the postdischarge mortality data on the sampled patients to compute age/sex-adjusted quarterly sample mortality rates in the 30-day period following admission, by disease and in the aggregate across diseases. To compare these data with the national MedPAR mortality data described above, we plotted the national age- and sex-adjusted 30-day quarterly mortality series on the same graph with the quarterly 30-day mortality data from our study sample, and marked off error bars two standard errors either way from the observed sample mortality series. We estimate that noncomparabilities between national and sample mortality values arising from our use of inclusion criteria were small.

Effects of Sampling Plan on Analysis

The sampling plan we employed had four features requiring special attention during the analysis. We now describe these features and how we dealt with them. (See App. A for further discussion of the actual hospital and patient sample plan and the special features of the sampling plan.)

1. Our oversampling of patients from hospitals serving an unusually large fraction of Medicaid patients would yield somewhat biased raw findings if the quality of care in high-Medicaid facilities differs substantially from that in other hospitals. To arrive at nationally representative findings, it was necessary to reweight our raw patient-level results, giving less weight to patients from high-Medicaid facilities. We describe above how we calculated the weights for this purpose. The weighted and unweighted results differed little in most of our major analyses. In what follows in this and subsequent sections, for simplicity we present unweighted findings unless otherwise indicated.

2. The clustering of our sampled patients in only five states, 30 areas, and 297 hospitals has implications for the accuracy of our results. If there is more similarity on average between two patients in the same state, area, or hospital in the care they receive than between two patients in different states, areas, or hospitals, and no adjustment for this so-called intracluster correlation is made (Cochran, 1977), the result will be an overstatement of the precision of our findings. To adjust for the clustering and produce standard errors that accurately reflect the information content of our sample, we (a) calculated provisional standard errors for all of our major estimates as if we had gathered our data using simple random sampling; (b) computed "inflation factors" based on intracluster correlations that measured the amount of information in our sample relative to that obtained in a simple random sample of the same size; and (c) multiplied our provisional standard errors by the inflation factors, thereby adjusting the significance of our results downward. The inflation factors ranged from 1.1, for outcomes such as inhospital and 30-day deaths, to 2.9 for our composite score, aggregating across diseases, which summarizes the quality of the processes of inhospital care. The latter inflation factor, which derives from an unusually high intracluster correlation of 0.16, indicates a remarkable degree of homogeneity within hospitals in the processes of care rendered.

3. The longitudinal nature of the hospital sampling, in which we gathered data in all our hospitals in both the pre- and post-PPS periods, also had implications for the accuracy of our results. Holding the hospital factor constant acted upon the precision of our findings in a manner opposite to that of the clustering: The latter decreased accuracy, when compared with independent simple random sampling in each of the pre- and post-PPS periods, and the former increased accuracy, because of positive correlations over time in the patterns of care given to patients within hospitals. We computed "deflation factors" to adjust simple random sampling standard errors for the longitudinal hospital sampling and found that the clustering and longitudinal effects approximately canceled each other in our analyses. Thus we were able to analyze the data essentially as if they had been gathered with simple random sampling in a cross-sectional fashion.

4. In this report we present results both at the disease-specific level and in the aggregate across diseases. Two issues arise in producing across-disease summaries: reweighting the diseases back to their actual frequencies in the Medicare population, and properly accounting for the degree to which pre- and post-PPS differences themselves differ by disease (i.e., accounting for interactions between the pre- and post-PPS periods and disease factors). Reweighting by disease prevalence is potentially necessary because we took samples of

roughly equal size in each of the six diseases, even though congestive heart failure is more than three times more frequent among Medicare patients than hip fracture, for example. We computed weights necessary to reweight our raw findings back to the population of all Medicare patients with one of the six diseases and did sensitivity analyses to see how much this reweighting affected our results. In most cases we examined, the weighted and unweighted results differed little. We therefore report unweighted findings unless otherwise noted. On pre- and post-PPS interactions by disease (a) we have tried not to emphasize across-disease summaries when the interactions are large, i.e., when there is serious disagreement among the diseases in the size of the pre- and post-PPS difference, and (b) we have tried to conservatively report the significance of the pre- and post-PPS effects when the pre- and post-PPS interactions by disease are small to moderate, by adjusting the pre- and post-PPS significance in a manner consistent with the size of the interaction (Scheffe, 1959).

RESULTS

We present results here based on the five nonpsychiatric diseases; we will report on depression results at a later date. The final sample size excluding depression patients was 14,012. We obtained accurate postdischarge mortality data on 12,823 of these patients.

Interrater Reliabilities

We assessed interrater reliabilities for each disease using both records known to the data collectors to be test cases ("known" records) and records on which they did not know they were being monitored ("unknown" records). Table 2.6 summarizes our findings. For ten known reliability records (the "gold-standard" columns of Table 2.6), each rated by an average of 47 different data collectors, we found across-disease item-level kappa scores averaging 0.86. For 162 unknown records rated by two data collectors (the "field data" column of Table 2.6), we obtained across-disease item-level kappa scores averaging 0.78. Overall, the 10th percentile of the distribution of our kappa scores was 0.63, the 90th percentile was 1.0, 5.6 percent of our kappa scores were below 0.4 (a level generally recognized as signifying poor reliability (Landis and Koch, 1977)), and 83 percent were above 0.75 (a level implying excellent reliability).

Effects Detectable with the Study's Sampling Resources

Table 2.7 presents typical examples of pre- and post-PPS effects detectable with the study's resources. It can be seen from the table that quite small disease-specific and aggregate differences in the average quality of processes of care, and a modest difference in aggregate mortality across all five diseases, stand a high chance of being found, whereas disease-specific differences in mortality would have to be fairly large to be detectable with high likelihood. The estimates in the table take into account both the potential information gain from the stratification and longitudinal hospital sampling built into the sampling plan and the potential information loss from the plan's clustering, and are typical of the power conclusions to be drawn about the many quantitative and qualitative response variables in our study: Our data resources were sufficient to find quite small disease-specific differences for quantitative outcomes and moderate differences aggregating across diseases for dichotomous outcomes.

Table 2.6

INTERRATER RELIABILITY RESULTS FOR SELECTED ITEMS, BY DISEASE

	Gold Standard #1[a]		Gold Standard #2[a]		Field Data[b]	
Abstraction Form Items	% Agreement	Kappa	% Agreement	Kappa	% Agreement	Kappa
Congestive Heart Failure						
Presence of CHF symptoms at admission (e.g., dyspnea)	1.00	(c)	1.00	(c)	1.00	(d)
Discharge status (e.g., discharged dead)	1.00	1.00	1.00	1.00	1.00	1.00
Physician's documentation of physical exam (e.g., presence or absence of heart murmur)	1.00	1.00	1.00	1.00	0.94	0.84
Nursing care: Frequency of blood pressure readings on hospital day 2	1.00	1.00	0.93	0.91	0.89	0.85
Medications: Use of loop diuretic on hospital day 1	1.00	1.00	0.85	0.35	0.94	0.88
Electrocardiogram obtained on hospital day 1	1.00	1.00	0.98	0.89	1.00	1.00
Digitalis level obtained ever during the hospitalization	0.94	0.85	0.95	0.88	1.00	1.00
Acute Myocardial Infarction						
Physician documentation of preadmission symptoms of AMI	0.98	0.00	1.00	1.00	0.97	0.16
Physician documentation of timing of onset of symptoms of AMI	0.98	0.54	1.00	1.00	0.97	0.65
Physician documentation of presence or absence of heart block	0.70	0.60	1.00	1.00	0.75	0.66
Use of coronary care unit, intensive care unit, telemetry, or wards	1.00	1.00	0.78	0.74	0.97	0.95
Use of digitalis	1.00	1.00	1.00	1.00	1.00	1.00
Location of AMI by electrocardiogram report	0.50	0.17	0.85	0.76	0.75	0.63
CPK isoenzyme value on hospital day 1	0.96	0.84	1.00	1.00	0.83	0.45
Pneumonia						
Presence of pneumonia symptoms at admission (e.g., cough, sputum, fever)	1.00	1.00	1.00	1.00	1.00	(d)
Patient's Medicaid status	1.00	1.00	0.97	0.88	0.74	0.20
Prehospital mental status (e.g., dementia)	1.00	1.00	1.00	1.00	0.91	0.71
Use of antibiotics before admission	0.98	0.91	1.00	1.00	0.91	0.71
First inhospital respiratory rate	0.98	0.98	0.97	0.97	0.85	0.83
First inhospital venous bicarbonate value	0.93	0.93	0.21	0.12	0.74	0.72
Preadmission residence (e.g., home)	0.82	0.67	1.00	1.00	0.71	0.59
CHF by chest X-ray on hospital day 1	1.00	1.00	1.00	1.00	0.91	0.80
Cerebrovascular Accident						
Presence of CVA symptoms/signs at admission (e.g., visual, sensory, motor, or speech deficit)	1.00	1.00	1.00	1.00	1.00	(d)
Patient's race	1.00	1.00	1.00	1.00	0.95	0.88
Discharge destination	1.00	1.00	0.97	0.96	0.95	0.93
History of CVA and/or transient ischemic attack before admission	1.00	1.00	0.92	0.85	0.86	0.74
Presence of coma on hospital day 1 and/or 2	1.00	1.00	0.95	0.78	0.86	0.64
Nurse documentation of patient's pupils on hospital day 1	0.91	0.82	1.00	1.00	0.81	0.62
Use of coumarin ever during the hospital stay	1.00	1.00	1.00	1.00	1.00	1.00
Presence of increased intracranial pressure on CAT scan (NMR or MRI scan) of brain	1.00	1.00	1.00	1.00	0.95	0.92
Use of prothrombin time (PT) or partial thromboplastin time (PTT) ever during hospitalization	0.96	0.90	1.00	1.00	0.90	0.80
Hip Fracture						
Presence of actual hip fracture at admission	1.00	1.00	0.96	0.00	1.00	(d)
Patient's Medicaid status	0.70	0.64	0.93	0.91	0.86	0.37
Preadmission residence	0.98	0.97	0.95	0.94	0.80	0.73
Type of hip fracture surgery	1.00	1.00	1.00	1.00	0.97	0.96
Location of hip fracture from the operative report	0.98	0.61	1.00	1.00	1.00	1.00
Number of physical therapy sessions on postoperative day 1	0.98	0.98	0.96	0.75	1.00	1.00
Use of parenteral antibiotics on day of surgery	0.80	0.09	0.95	0.78	0.91	0.85
Radiographic evidence for osteoporosis of fractured hip	0.53	0.00	0.51	0.00	0.57	0.33
First serum albumin value on hospital day 1 or 2	0.96	0.96	1.00	1.00	0.86	0.82

[a] Gold-standard #1 and #2 records were disease-specific records, known by the data collectors to be test records, against which the data collectors' abstraction form responses were tested. #2 records differed from #1 records in that #2 records were compared with known gold standards only after supervisory nurses and physicians had checked the accuracy of the abstraction form data.

[b] Field data records are pairs of abstraction forms written by two data collectors abstracting the same medical record under field conditions, i.e., the data collectors did not know that their performance was being monitored.

[c] For gold-standard #1 and #2 records, kappa scores were not calculated if all abstraction forms studied had 100 percent agreement for the item and there was no variation in the item response.

[d] For field data records, kappa scores were not calculated if there was no variability in the item response across the pairs of study cases.

Table 2.7

PRE- AND POST-PPS DIFFERENCES IN 30-DAY MORTALITY, ADJUSTED FOR SICKNESS AT ADMISSION
(In percent)

Disease	Pre-PPS Rate	Pre-Post Change Detectable with 80% Power	Standard Error for Estimated Pre-Post Difference
Congestive heart failure	14.7	3.4	1.3
Acute myocardial infarction	24.4	4.2	1.5
Pneumonia	15.9	3.6	1.3
Cerebrovascular accident	21.3	4.0	1.4
Hip fracture	5.1	2.1	0.8
Aggregates	16.7	1.6	0.6

NOTE: The study's power to find 1.1 point or greater disease-specific pre- and post-PPS differences on a 100-point process scale with patient-level standard deviation 10 is at least 80 percent. In the aggregate across diseases, 0.5 point or larger differences on such a scale would be detectable with at least 80 percent power.

Effects smaller than those referred to in Table 2.7 as detectable with 80 percent power may actually be found to be significant by the study, as can be seen from the column giving standard errors for the estimated pre- and post-PPS differences in 30-day mortality, adjusted for sickness at admission.

Representativeness of Final Sample

Tables 2.8 and 2.1 compare our sample with known national prevalences on a number of important hospital characteristics. It is evident that after reweighting, the sample matches the nation closely with respect to hospital size, city size, percentages of Medicare and Medicaid patients, teaching intensity, and hospital ownership.

Figure 2.1 compares our sampled age- and sex-adjusted 30-day mortality values with known national values on a quarterly basis, in the aggregate across diseases; the results were similar at the disease-specific level. The national values fell within the sample 95 percent confidence limits in 11 out of the 12 quarters, and the pattern of positive and negative deviations of the sampled values from the national mortality figures reveals no bias. Both of these observations are consistent with the hypothesis that our sample is representative of the nation with respect to 30-day mortality.

Composition of Final Patient Sample

Table 2.9 gives various characteristics of the study's patient sample, both before and after PPS, by disease and in the aggregate across diseases. Forty-one percent of our patients were over 80 years old; 43 percent were male; 19 percent were nonwhite; 12 percent had a do not resuscitate (DNR) order written at some point during the hospitalization; 15 percent had Medicaid status; and 14 percent were admitted from a nursing home. Demographics remained quite stable from pre- to post-PPS, but the fraction of patients with a DNR order rose sharply and significantly for acute myocardial infarction, congestive heart failure, pneumonia, and overall, in the aggregate from 10.5 percent pre-PPS to 13.7 percent post-PPS ($p < 0.01$), a 30 percent increase. (See App. A for further details about the demographic characteristics of study patients.)

Table 2.8

THE SAMPLE COMPARED WITH THE NATION
(In percent)

Category	National Prevalence	Raw Sample Prevalence	Reweighted Sample Prevalence
Percentage of Medicare Patients Treated at the Given Hospital[a]			
0–28	25	27	25
29–33	25	25	26
34–39	25	19	24
40–47	15	16	16
48+	10	12	10
	100	100	100
Percentage of Medicaid Patients Treated at the Given Hospital			
0–3.8	25	24	25
3.9–7.3	25	16	24
7.4–10.8	25	23	25
10.9–16.7	15	18	16
16.8+	10	19	11
	100	100	100
Ratio of Interns and Residents to Beds			
0	65	65	65
0–0.274	25	26	25
0.274+	10	9	10
	100	100	100
1981 Standard Metropolitan Statistical Area (SMSA) Status			
Rural	21	22	21
Up to 250,000	13	10	11
250,000–1,000,000	26	23	26
1,000,000–2,500,000	22	25	24
2,500,000+	18	21	18
	100	100	100
Hospital Ownership (Profit Status, Church Affiliation, etc.)			
Church voluntary/nonprofit	22	22	22
Other voluntary/nonprofit	46	39	45
Proprietary	11	12	12
County	8	14	8.4
State, city, city/county	5	4.3	4.0
Hospital district	8	9.0	9.2
	100	100	100

[a] These figures are at the patient level, i.e., 25 percent is the fraction of patients treated nationally at hospitals with percentages of Medicare patients between 0 percent and 28 percent, not the percentage of such hospitals nationwide. National data are from AHA (1984) and HCFA (1986b).

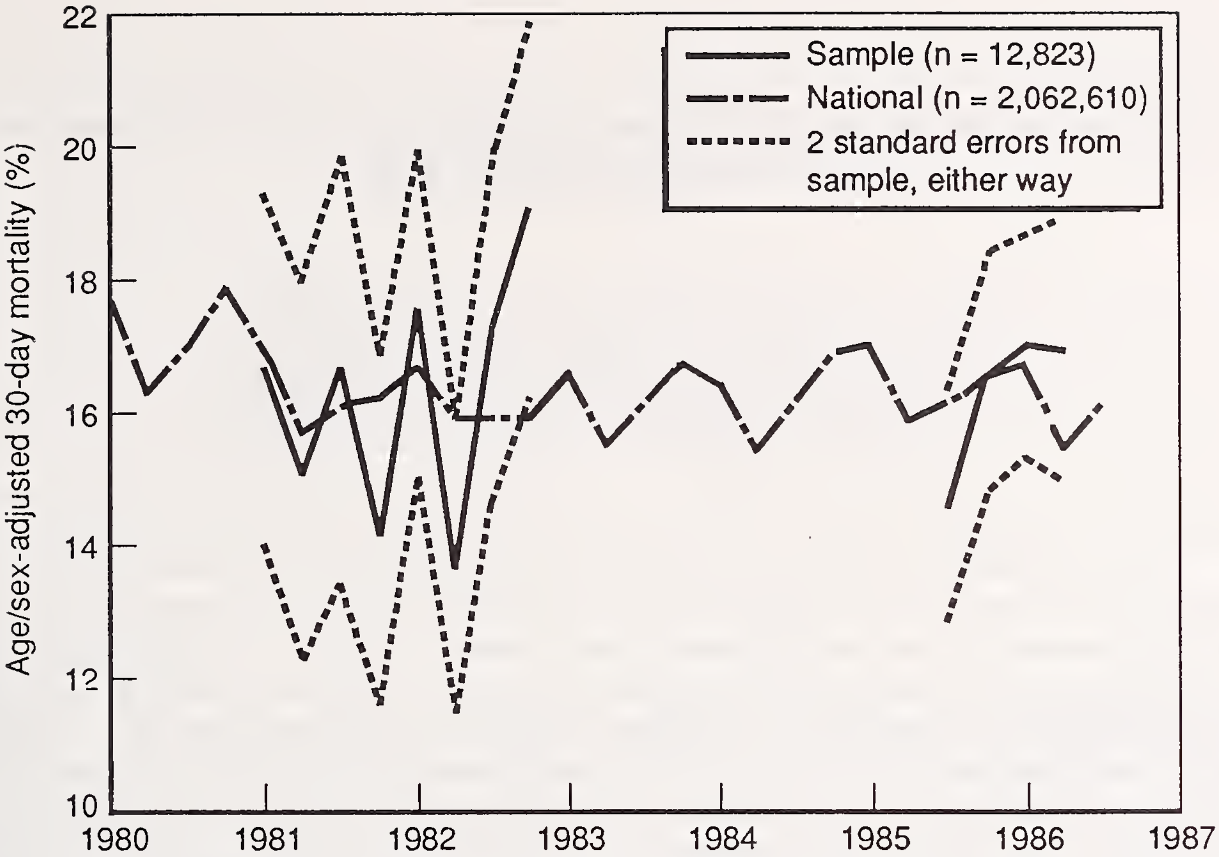

Fig. 2.1—Quarterly 30-day mortality trend for five diseases

Table 2.9

CHARACTERISTICS OF THE STUDY SAMPLE, BY DISEASE AND TIME PERIOD[a]
(In percent)

Patient Characteristic	CHF		AMI		PNE		CVA		HIP		Total		
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Total
80 or more years old	41	41	25	27	41	42	41	41	58	58	41	42	41
Male	43	45	53	50	51	51	45	44	21	23	43	43	43
Nonwhite	23	22	18	16	19	20	22	20	14	13	19	18	19
Medicaid	16	15	12	12	19	19	14	13	17	15	15	15	15
Preadmission residence nursing home	8	9	4	5	22*	26*	12	11	24*	20*	14	14	14
Sample size	1,359	1,465	1,416	1,437	1,341	1,408	1,382	1,442	1,358	1,404	6,856	7,156	14,012

NOTE: * Pre- and post-PPS difference is significant ($p < 0.01$).
[a] Results were reweighted to achieve national representativeness (see the text).

III. CHANGES IN SICKNESS AT ADMISSION FOLLOWING THE INTRODUCTION OF PPS

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The introduction in 1983 of Medicare's Prospective Payment System has raised a number of clinical and policy questions. Did the change in financial incentives from a cost-plus reimbursement system to a fixed-price system based on DRGs result in less sick patients being admitted to the hospital? Did mortality within 30 or 180 days following hospitalization, after adjusting for sickness at admission, change when prospective payment was introduced? Measuring how sick a patient is at the time of hospital admission is a prerequisite for answering such questions. In this section we present measures of sickness at admission that can be used to answer these two questions for five diseases: congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular disease, and hip fracture. These measures can also be used to aid clinical decisions at the individual patient level and to help hospitals monitor their outcomes. After describing the measures, we present data showing how sickness at admission changed after the introduction of prospective payment.

In developing our measures of sickness at admission, we paid special attention to previously published severity measures, including those developed to predict death for ICU patients (Knaus et al., 1985; Kruse et al., 1988; and Lemeshow et al., 1985) and measures developed for specific diseases (Killip and Kimball, 1967; Norris et al., 1969; Goldman et al., 1977; and Daley et al., 1988).

METHODS

Variables Measuring Sickness at Admission

We used literature review, clinical judgment, and disease-specific consensus panels to identify variables that have been considered important clinical predictors of either inhospital death, death within 30 or 180 days of hospitalization, nonfatal complications, readmissions, or prolonged nursing home residence. Variables were included if (1) they accurately described the patient's status at the time of hospital admission, (2) they were frequent enough to be worth collecting, and (3) they were reliably recorded in the medical record (Kahn et al., 1988a). (Further details about the development and collection of sickness at admission variables are presented in Appendix B.)

We used disease-specific abstraction forms to collect data about sickness at admission from the medical records of hospitalized patients (Kahn et al., 1988b; Kosecoff et al., 1988; Roth et al., 1988; Rubenstein et al., 1988; and Sherwood et al., 1988). We included measures of patient sickness at admission based on the reason for the hospital admission (morbid conditions) and on other conditions that might influence outcomes (comorbid conditions). For each patient, we collected data about acute and chronic morbid and comorbid diseases, function, the number of body systems with pathology, and the APACHE II Acute Physiological Score (APS) variables (Knaus et al., 1985). For patients hospitalized with acute myocardial infarction, we also collected data used to score the Norris Coronary Prognostic Index and the Killip Scale (Killip and Kimball, 1967; and Norris et al., 1969). For hip fracture patients, we collected data for the Goldman Preoperative Risk Index (Goldman et al., 1977). Table 3.1 lists variables collected for all five study diseases, as well as those variables collected specifically for each disease.

Fifty-two data collectors (nurses or medical records technicians) with prior experience in medical record abstraction collected the data. We document data availability and inter-rater reliability in Sec. II. Abstractors collected data about sickness at admission from physicians' and nurses' notes (including emergency room notes), laboratory results, and radiographic reports. In all instances, we collected the first available data for the patient after admission. If the patient had missing laboratory or radiographic data on day 1, we accepted data from day 2 because day 2 values may represent the admission status of patients admitted late at night.

Analytic Methods

Modeling decisions (scaling of important variables and subsequent variable selection) were based on a two-thirds random sample of the patients with each disease. We validated our modeling choices by repeating the modeling effort on the other third of the cases and on five bootstrap (Altman and Anderson, 1989) replicates of the datasets. Final weights (coefficients) were estimated on the full sample. The weights for the variables that were used to predict two outcomes are given here: death within 30 and 180 days after admission.

Our goal was to create simple disease-specific scales of the risk of dying that were similar in form to the APACHE APS scales. We categorized and scaled all but five variables using our own clinical judgment and the APACHE item scaling. For example, for patients with congestive heart failure, serum AST (SGOT) from 40–79 U/L was scored as 2 points, and AST greater than 80 U/L was scored as 4 points. For all variables, normal and missing values received a score of zero, and the maximum score is assigned to the sickest people. For variables defining the patients' medical and functional pathology, we assumed that patients did not have a condition unless it was mentioned in their medical record. The scoring rules for all variables used in the final scales are shown in Table 3.2.

In initial analyses, five variables (systolic blood pressure, age, blood urea nitrogen (BUN), coma, and temperature) predicted inhospital mortality especially well. We rescaled these variables, based on average mortality at different levels of the variable. We scored age, BUN, and temperature by simply subtracting the mean value, across all patients with the disease, from the patient's value. Higher initial systolic blood pressure was a good sign for all diseases but cerebrovascular accident. We scaled it based on its effect on inhospital mortality for patients with congestive heart failure, and the scale shown in Table 3.2 held up well for all diseases. The relative impact of confusion (altered mental or neurologic status) and coma on death varied from disease to disease, and we did a more clinically detailed scaling of neurologic status for cerebrovascular accident, where it was overwhelmingly the strongest predictor of death.

Table 3.1

COMPLETE TABLE OF VARIABLES COLLECTED TO MEASURE SICKNESS AT TIME OF HOSPITAL ADMISSION

CHF	AMI	HIP	PNE	CVA	All Diseases[a]
		Acute Conditions			
Recent angina (past week)	Shock[b] Location of infarction[c] Extent of infarction (e.g., transmural)[c] Difficulty using limbs	Fracture location by M.D. report (e.g., intertrochanteric) Fracture stability by M.D. report (e.g., garden stage, displacement) Atrial arrhythmias[d] Ventricular arrhythmias[d] Heart block by EKG[d]	Recent influenza Respiratory distress Wheezing Empyema Lung abscess Meningitis Pericarditis Endocarditis	Hemorrhagic infarction Recent angina (within 1 week) Recent CHF (within 1 week)	Shortness of breath Chest pain Arrest Intubation (except HIP)
		Demographics			
					Age,[c,e] sex, race
		Prior Chronic Conditions			
Noncompliance with therapy Difficulty using limbs		Status post pneumonectomy Deep venous thrombosis Pulmonary embolism Parkinson's disease Paget's disease Osteoarthritis Rheumatoid arthritis Osteoporosis Prior contralateral hip fracture Hip malignancy (new diagnosis this admission)	Immunocompromise Multiple myeloma Status post splenectomy Respiratory failure Pneumonectomy Aspiration Dysphagia Thoracic neuromuscular disease Recent thoracic or abdom. surg. Interstitial lung disease Nasogastric tube before admission Tracheostomy Lung cancer (new diagnosis during admission) Morbid obesity Current alcoholism Prior hospitalization for lung disease	Immunocompromise Deep venous thrombosis Malnutrition Nasogastric tube before admission Current alcoholism Morbid obesity Temporal arteritis Systemic lupus erythematosis Status post carotid endarterectomy	Valvular disease Angioplasty or coronary bypass surgery Angina[d] Pacemaker Atypical chest pain (except HIP and PNE) Myocardial infarction[c] CHF Hypertension (except HIP and PNE) Arrhythmia (except CHF and AMI) Arterial disease (except HIP and PNE) Emphysema, COPD Use of home oxygen (except CVA) Cancer diagnosis Cirrhosis[e] Diabetes

Table 3.1—continued

			Demographics		
					Age,^{c,e} sex, race
			Prior Chronic Conditions		
					Renal failure Cerebrovascular accident Psychosis or depression (except PNE) Malnutrition (except CHF and AMI) Current smoking (except HIP) Hospitalization within 6 months (except AMI)
CHF	AMI	HIP	PNE	CVA	All Diseases
			Function		
					Dementia Urinary continence Ambulatory status From nursing home
			Radiographic		
		Fracture location (e.g., intertrochanteric) Fracture displacement Fracture comminution Fracture impaction Fracture stable Fracture valgus Fracture varus Stress fracture		Increased intracranial pressure by CAT scan Lacunar infarc. by CAT scan Hemorrhagic infarc. by CAT scan	CHF by chest x-ray^{b,c} PNE by chest x-ray (except AMI)
			Physical Examination		
	Lung not clear to auscultation (e.g., rales) CPK isoenzymes LDH isoenzymes Cardiomegaly^{c}			Speech deficit Facial deficit Visual deficit Motor deficit Sensory limb deficit Unresponsive to painful stimuli^{g} Unresponsive to touch^{g} Unable to follow commands^{g} Decorticate posturing^{g}	Coma (except HIP)^{f,g} Confusion or altered neurologic status^{d,f,g}

Table 3.1—continued

	Laboratory Studies		
Digitalis level Positive blood culture	Positive blood culture Positive urine culture	Sedimentation rate	Oxygenation (A-aD02 or p02)^{f} Arterial pH^{f} Serum sodium^{f} Serum potassium^{f} Serum creatinine^{f} Blood urea nitrogen^{f} Venous bicarbonate (except HIP)^{f} Hematocrit or hemoglobin^{f} White blood count^{f} Serum CPK (except HIP) Serum SGOT Serum bilirubin Serum albumin Missing laboratory values
	Prior Medications		
Beta blocker Other left vent. depressant Antiarrhythmic	Antibiotics Aminophylline	Anticoagulants Antiarrhythmic	Digitalis (except CVA) Insulin Systemic steroids (except AMI)
	Vital Signs		
			Temperature^{f} Systolic blood pressure^{c,f} Diastolic blood pressure^{f} Heart rate^{f} Respiratory rate^{f}

[a] We measured the body system count for each disease by counting the number of each of the following body systems evincing pathology: cardiac, pulmonary, hepatobiliary, endocrine, arterial, renal, neurologic, psychiatric, oncologic, immunologic, hematologic, musculoskeletal, and nutrition.

[b] These variables are part of the Norris Coronary Prognostic Index.

[c] These variables are part of the Killip scale.

[d] These variables are part of the Goldman Preoperative Risk Index.

[e] These variables are part of the APACHE II Chronic Health Evaluation system.

[f] These variables are part of the APACHE II Acute Physiologic Score (APS) system. Systolic and diastolic blood pressure are combined in the APACHE APS into a mean blood pressure value ((2 × diastolic + systolic blood pressure)/3). The APACHE APS system uses venous bicarbonate only if no arterial blood gas value is available.

[g] These variables are part of the RAND CVA coma scale.

Table 3.2

SCORING FOR SICKNESS-AT-ADMISSION VARIABLES THAT PREDICT DEATH WITHIN 30 AND 180 DAYS AFTER ADMISSION[a]

Variable	Maximum Achievable Score[b]	Definition
APACHE II APS	53	Sum of 13 scales assessing patient's vital signs, blood studies, and mental status (CHF, AMI, PNE, HIP)[c]
APACHE CHE[d]	1	Severe chronic failure of liver, cardiovascular, respiratory or renal systems, or immunocompromised = 1 (CHF, CVA, HIP)
Age (standardized)	—	(Age-mean sample age of 78 for CHF and PNE, 75 for AMI, 77 for CVA, 81 for HIP)/years
Systolic blood pressure	5	< 90 mm Hg = 5; 90–99 mm Hg = 4; 110–119 mm Hg = 3; 120–139 mm Hg = 2; 140–159 mm Hg = 1; 160+ mm Hg = 0 (5 diseases)
CHF by chest X-ray	3 =	Severe CHF by X-ray = 3 (PNE, CVA, HIP); moderate CHF by X-ray = 2 (CVA, HIP), 1 (PNE); mild CHF by X-ray = 1 (PNE, CVA, HIP); pleural effusion by X-ray = 1 (CHF)
BUN (standardized)	—	(BUN—mean sample BUN of 10 mmol/L CHF, 8 AMI, 9.5 PNE)/7 mmol/L (CHF, AMI, PNE)
APACHE II coma score[e]	9	Coma = 9 (CHF, PNE); confusion or neurologic change = 5 (CHF, PNE, HIP)
CVA coma score	5	Posturing/no response to pain = 5; coma by both physician and nurse = 4; coma by physician or nurse = 3; neurologic change or unable to follow commands = 2; confusion = 1 (CVA)
From nursing home	1	Prior residence in skilled nursing facility, intermediate care facility, extended care facility, or nursing home with unspecified type = 1 (CHF, AMI, CVA, HIP)
Mean blood pressure[e]	4	Mean blood pressure: ≥ 160 or ≤ 49 mm Hg = 4; 130–159 mm Hg = 3; 110–129 mm Hg or 50–69 mm Hg = 2 (CHF, CVA)
Heart rate[e]	4	First heart rate value: ≥ 180 or ≤ 39 beats/minute = 4; 140–179 or 40–54 beats/minute = 3; 110–139 or 55–69 beats/minute = 2 (AMI)
Serum sodium[e]	4	First serum sodium value: ≥ 180 or ≤ 110 mmol/L = 4; 160–179 or 111–119 mmol/l = 3; 155–159 or 120–129 mmol/l = 2; 150–154 mmol/L = 1 (CHF)
Serum creatinine[e]	4	First serum creatinine value: ≥ 300 μ mol/L = 4; 180–300 μ mol/L = 3; 133–168 or < 53 μ mol/L = 2 (HIP)
Oxygenation[e]	4	Partial pressure of oxygen: p02 < 55 or A-aD02 ≥ 500 = 4; p02 = 55–60 or A-aD02 = 350–499 = 3; A-aD02 = 200–349 = 2; p02 = 61–70 = 1 (AMI, HIP)
Hematocrit[e]	4	Serum hematocrit: ≥ 0.60 or < 0.20 = 4; 0.50–0.60 or 0.20–0.30 = 2; 0.46–0.50 = 1 (CHF)
White blood cell count[e]	4	Serum white blood cell count: ≥ 40 or < 1 x 10^9/L = 4; 20–39.9 or 1 – 2.9 x 10^9/L = 2; 15–19.9 x 10^9/L = 1 (CVA)
Digitalis toxicity	4	Toxic digitalis level: > 2.8 nmol/L = 4 (CHF)
Serum AST (SGOT)	4	Serum AST (SGOT) value: ≥ 80 U/L = 4 (CHF), 2 (AMI); 40–79 U/L = 2 (CHF), 0 (AMI)
Creatinine (CK) score	4	CK value: > 3 times laboratory's highest normal value = 4; < 3 but > 1.3 times laboratory's highest normal value = 2 (AMI)
Serum albumin	4	Serum albumin value: < 25 g/L = 4 (CVA, HIP); = 3 (PNE); 25–30 g/L = 2 (PNE, CVA, HIP); > 30 g/L or not tested, but patient described as malnourished = 3 (HIP, PNE)
Male	1	Male = 1 (CHF, HIP)
Noncompliance	1	Noncompliance with medications or diet = 1 (CHF)
Use of ventricular depressant	1	Use of ventricular depressants (e.g., verapamil, disopyramide, clonidine) = 1 (CHF)
Antiarrhythmic medications	1	Use of antiarrhythmic medication = 1 (CHF)
Difficulty with limbs	1	Difficulty with arm and/or leg function (CHF)
Prior hospitalization	1	Hospitalization within 6 months = 1 (CHF, PNE)
Location of AMI	2	Location of AMI: anterior = 2, inferior or transmural but unspecified = 1; subendocardial = 0 (AMI)
Cardiac disease[f]	8.7	Age > 80 = 3.9; age 70–79 = 3.1; age < 70 = 2.3; cardiomegaly by X-ray = 1.1; severe CHF by X-ray = 3.3; moderate CHF by X-ray = 2; mild CHF by X-ray or lungs not clear on exam = 1; prior angina = 0.4 (AMI)
Prior CHF	1	History of CHF or use of digitalis at time of admission = 1 (AMI)
Prior valve disease	1	History of mitral, tricuspid, aortic, pulmonic valve disease, or valvular surgery = 1 (AMI, CVA)
Prior diabetes	1	History of diabetes = 1 (AMI, CVA)
Intubation	1	Oropharyngeal or nasopharyngeal intubation = 1 (AMI)
Body system score	12	Count of number of body systems (e.g., cardiovascular, respiratory) involved with acute or chronic disease (AMI)
Infarction type	3	Hemorrhagic infarction = 3; lacunar infarction = –1 (CVA)
Shortness of breath	1	Dyspnea noted by physician and/or nurse = 1 (PNE, CVA)
Arrest in emergency room	1	Cardiac and/or respiratory arrest or intubation in emergency room = 1 (CVA)
Recent CHF	1	CHF diagnosed as active within 1 week of admission = 1 (CVA)
Malnutrition	1	Noted by physician at admission = 1 (CVA)

Table 3.2—continued

Variable	Maximum Achievable Score[b]	Definition
Nonambulatory day 1	1	Noted by physician or nurse as nonambulatory day 1 (CVA)
Respiratory distress	1	Noted by physician (PNE)
Septic complications	1	Empyema, lung abscess, pericarditis, or meningitis present at admission (PNE)
Prior respiratory failure	1	Noted by physician (PNE)
Thoracic disease	1	Neuromuscular disease (e.g., amyotrophic lateral sclerosis, myasthenia gravis) = 1 (PNE)
Prior cancer score	3	Poor prognosis cancer or cancer treated by chemotherapy or radiation = 3; cancer treated with hormone therapy = 2; cancer with no evidence of activity = 1 (PNE)
New lung cancer	1	New cancer diagnosis made during the hospitalization = 1 (PNE)
Home oxygen	1	Use of home oxygen before admission = 1 (PNE)
Nonambulatory preadmission	1	Noted by physician or nurse as nonambulatory before admission (PNE)
RAND comorbidity scale	45	A weighted sum of chronic comorbid conditions present at admission (PNE, HIP)[g]
Temperature (standardized)	—	Temperature − 37.6 (HIP)
Pneumonia by chest X-ray	1	Chest X-ray report: bilateral pneumonia without CHF = 1; unilateral pneumonia or infiltrate = 1/2 (HIP)
Prior renal failure	1	History of renal transplant or chronic dialysis, and creatinine value on admission ≥ 2.0 mg/dl (HIP)
Prior cerebrovascular accident	1	Cerebrovascular accident before admission = 1 (HIP)
Prior chronic obstructive pulmonary disease (COPD)	1	COPD, emphysema, asthma, or chronic bronchitis before admission (HIP)

[a] Values are given only for variables included in the scales that predict mortality 30 and 180 days after admission. Laboratory values are given in Système International (SI) units.

[b] The maximum achievable score is the difference between the healthiest and sickest categories in all instances where the healthiest category is scored 0. This is the case for all variables except "cardiac disease score" and "infarction type," BUN, age, and temperature.

[c] The variable was used in the final sickness-at-admission score for the diseases in parentheses.

[d] CHE is chronic health evaluation from the APACHE CHE measure.

[e] A component of the APACHE APS score. We use the standard APACHE scores.

[f] Age, cardiomegaly, pulmonary congestion, and history of ischemia as defined by the Norris Coronary Prognostic Index.

[g] In the sum (with weights in parentheses) are 16 measures of prior conditions: cancer (3), cirrhosis (2), diabetes (1), cerebrovascular accident (2), chronic renal failure (3), valvular disease or angina or myocardial infarction or heart surgery (2), congestive heart failure (1), arrhythmias (2), swallowing disorder (e.g., aspiration, dysphagia) (2), use of nasogastric tube (3), hospitalization in last month (2), thoracic or abdominal surgery in last month (2), disease of thorax (3), multiple myeloma (2), splenectomy (2), dementia (2), and five measures of current problems: smoking (2), alcoholism (2), morbid obesity (2), hypoalbuminemia or malnourishment (3), and immunocompromised (2).

Variable Selection and Weighting

We screened variables for the final regressions according to a rule that combined clinical judgment with statistical evidence. Variables were rated 1, 2, 3, or 4 by clinician raters for their expected association with poor hospital outcomes. Using this rating, variables were kept for possible inclusion in the scale (a) if they were strong predictors of death (regression t statistics > 2.5 in regressions that included systolic blood pressure, age, the APACHE APS scales, and, in the case of cerebrovascular accident, the detailed scale describing neurological status); (b) if they were medium predictors (t > 2) with clinical score > 1; or (c) if t > 1.5 and the clinicians expected a strong relationship with death (a clinical score of 3 or 4).

Finally, we used logistic regression for each outcome (e.g., mortality within 30 days of admission) on all the candidate variables to assign weights to the variables. The final weights were rounded to the nearest integer multiple of the APACHE APS weights (i.e., logistic regression coefficients were divided by the coefficient for APACHE APS and rounded). Insignificant (p > 0.05) variables and six measures of sickness implausibly associated in the regressions with decreased mortality were dropped. (Two variables expected to be associated with relatively low levels of sickness were kept: use of ventricular depressants and noncompliance with therapy for congestive heart failure patients.) To estimate the predictive ability of these sickness-at-admission variables conservatively, we divided the sample into ten equal parts at random. The R-squared values we report are the averages of the squares of the simple correlations between outcomes in each tenth and predictions based on the other 90 percent of patients. Because APACHE APS weights are predetermined (not derived from our dataset), we did not need to use this technique to determine the R-squared for APACHE APS.

To summarize the predictive power of our final scales, we compared the R-squared values for our scales with those from less complete measures of sickness at admission calculated on our dataset: age and sex alone; age, sex, and APACHE; the APACHE variables, but reweighted for better predictive performance in our patient cohorts; and reweighted APACHE plus the body system count. We also compared our R-squared values with those from the Medicare Mortality Predictor System (MMPS) (Daley et al., 1988). We were unable to do this directly with our dataset, because MMPS decisions on inclusion of patients with end-stage cancer and use of information on DNR orders were different from ours. Nevertheless, published MMPS R-squared values are closely comparable to ours, because (1) the MMPS study sample was drawn in a manner similar to ours, and (2) the MMPS investigators used abstraction forms that were minor variations on subsets of our own abstraction instruments.

Changes in Laboratory Ordering and Reporting

Over the period from 1981 to 1986, we observed substantial increases in the number of arterial blood gases ordered, and lesser increases in the ordering of venous blood chemistry tests such as sodium, potassium, bicarbonate, and creatinines. There were also increases in abnormal laboratory values, as well as increases in physicians' reporting of comorbidities over time. We were concerned that these differences might lead to artifactual increases in sickness at admission.

To investigate this, we divided the sickness items into three categories: recording-sensitive (noted in Table 3.3), laboratory, and recording-insensitive. We assumed, conservatively, that the change in the recording-insensitive part of the scale (i.e., measurement of vital signs, sex, and age) represented the true change in sickness over time, and for analyses of changes over time we reduced the changes that we observed in the laboratory and recording-sensitive components of the sickness scale accordingly.

For the laboratory scale, this was done by using missing laboratory value indicators (one representing standard blood chemistries, which typically were missing as a group, and one representing arterial blood gases) in the regression analyses that related sickness to outcome. Our analyses of missing values showed that, on average, patients missing blood chemistries died slightly more often in the 30 days following admission than did those with normal measured blood chemistries, whereas patients missing blood gases were less likely to die than those with normal measured blood gas values. Adjustments were made to conform with these findings and to make the changes over time in the laboratory abnormalities scale proportional to changes in the age and vital signs scale. Other missing value indicators, such as missing AST or bilirubin or no data on preadmission ambulation, were included in the final regressions (1) if the corresponding variables (e.g., ambulation) were included in the final scales, and (2) if patients missing the variables had a significantly different chance of dying than did patients for whom the variables were not missing and normal.

Table 3.3

WEIGHTS FOR SICKNESS-AT-ADMISSION VARIABLES THAT PREDICT DEATH WITHIN 30 DAYS AFTER ADMISSION

Variable	Observed Range	Weights^{a}				
		CHF	AMI	PNE	CVA	HIP
APACHE II APS^{b,c}	33	0.5	1**	1*		1**
Age standardized	40	0.2	0.4*	0.45*	0.25*	0.15*
Blood pressure score	5	4***	3.5***	2*	2*	1*
CHF by chest X-ray	3	4*		3	3	3*
BUN standardized	9	3**	2	3*		
Coma score^{c}	9	0.5		0.77		–0.8*
CVA coma score^{c}	5				5**	
Mean blood pressure	4				1	
Heart rate	4		–1			
Serum sodium	4	2				
Oxygenation	4					2*
Hematocrit	4	–0.5				
White blood count	4				4*	
Digitalis toxicity	4	1.5				
Serum SGOT	4	1.5*	3.5**			
CPK score	4		–1.5*			
Infarction type	4				3**	
Serum albumin	3			2		1*
Location of AMI	2		6**			
Intubation^{c}	1		9*			
Body system count^{c}	6		2*			
Shortness of breath^{c}	1			7*	5*	
Arrest in emergency room^{c}	1				9	
Recent CHF^{c}	1				12*	
Prior diabetes^{c}	1				4*	
From nursing home^{c}	1				3	
Respiratory distress^{c}	1			6*		
Septic complications^{c}	1			20*		
Prior respiratory failure^{c}	1			10		
Thoracic disease^{c}	1			15		
Recently hospitalized^{c}	1			4		
Nonambulatory^{c}	1			12*		
Temperature (standardized)	10			–3*		
Male	1					3*
Pneumonia by chest X-ray	1					6
Prior renal failure^{c}	1					18*
Prior cerebrovascular accident^{c}	1					3*
Prior COPD^{c}	1					2
1985–1986 multiplier		0.102	0.082	0.082	0.115	0.112
1985–1986 intercept		–3.43	–3.11	–4.22	–3.96	–3.99
1985– 30-day postadmission mortality		0.131	0.248	0.170	0.199	0.048

NOTE: Significance is shown by asterisks: No asterisk shows $2 < | t | < 3$, * = $3 < | t | < 5$, ** = $5 < | t | < 7$, and *** = $| t | > 7$.

[a] Logistic regression coefficients were rounded to simple multiples of the APACHE coefficient.

[b] APACHE II APS.

[c] Recording-sensitive items (in APACHE II APS only the coma score is recording-sensitive).

Finally, because many of the recording-sensitive items are quite rare, and thus subject to substantial random variation, we reduced their effect on sickness at admission uniformly by a factor that made the changes over time in the sum of recording-sensitive variables proportional to the changes in vital signs and age. Table 3.4 includes a table of all the adjustments and a detailed example of their use. To the extent that the increase in abnormalities and comorbidities is due to sicker patients rather than to changed medical practice, these adjustments will lead us to underestimate increases in sickness at admission following the introduction of prospective payment. A second test of recording and laboratory abnormality creep is shown in Table 3.5. We tested whether the relationship between severity and mortality was stable over time by regressing mortality on sickness at admission, an indicator for post-PPS, and their interaction. Only for pneumonia was the interaction significant, and even in that disease the interaction was very small compared to the main effect of sickness. Thus, the adjustments made directly for recording and test-"creep" appear to be adequate.

RESULTS

Frequency distributions for sickness-at-admission variables are presented in App. B.

Sickness-at-Admission Scales

Sickness-at-admission variables that were used in the final equations to predict 30- or 180-day postadmission mortality are given in Table 3.3. Table 3.4 shows how data in Table 3.3 can be used with data in Table 3.2 to predict the probability of death within 30 days for a patient with a particular disease receiving average processes of care in 1985–1986. The weights in Table 3.3 give the relative importance of various characteristics in prognosis; for example, in pneumonia patients, respiratory distress (with weight 6) is equivalent in prognosis to 6/0.45 = 13.3 years difference in age.

The models based on the bootstrap and validation datasets were similar to those presented in Table 3.3. The choice of variables, especially rare variables, varied somewhat from replicate to replicate, but the predicted death probabilities from the different models were very similar to those derived from Table 3.3 (average pairwise correlation: 0.94).

The numbers at the bottom of Table 3.3 are used to convert the sickness-at-admission score for a patient to the predicted probability of death within 30 days, assuming average process of care in the 1985–1986 sample (Table 3.4). The multiplier is the change in the log odds of dying from each one point change in the sickness-at-admission score, and the intercept is the log odds of dying for people with no abnormalities.

Blanks in Table 3.3 indicate that the variable did not add to the prediction of death for a particular disease. Variables listed in Table 3.1 but not in Table 3.3 did not add to prediction for any of the five diseases. In particular, we tested 64, 61, 82, 83, and 74 variables, respectively, for congestive heart failure, acute myocardial infarction, cerebrovascular accident, pneumonia, and hip fracture, and eventually included 18, 20, 12, 25, and 22 variables, respectively, in the final disease-specific measures (counting each of the 13 variables in APACHE APS separately). Many of the variables that were dropped are strong predictors of death when considered by themselves but are overshadowed by other correlated variables that are more closely linked to death.

All variables in Table 3.3 are significant at least at the 0.05 level. Many variables were significant at higher levels. APACHE APS with rescored low blood pressure, BUN, and coma were important in most diseases, as were age and the presence of CHF by X-ray. The

Table 3.4

CALCULATION OF PREDICTED 30-DAY AND 180-DAY POSTADMISSION DEATH PROBABILITIES FOR A HYPOTHETICAL PNEUMONIA PATIENT RECEIVING AVERAGE CARE IN THE 1985-1986 PERIOD

Assumed Characteristics	Item Score (from Table 3.2)	Weight (from Table 3.3)	Product
30-Day[a]			
Heart rate, blood pressure, potassium and white blood cell abnormalities for an APACHE APS score of 10	10	1.0	10.0
88 years old (88 – (78, the mean age) = 10)	10	0.45	4.5
Systolic blood pressure of 80	5	2.0	10.0
BUN and temperature same as sample mean	0		0
Recently hospitalized	1	4.0	4.0
No data about preadmission ambulation	0		0.0
All other characteristics normal			0.0
Sickness-at-admission score			28.5
180-Day[b]			
30-day sickness-at-admission score	28.5	1.0	28.5
88 years old (88 – (78, the mean age) = 10)	10.0	0.15	1.5
Home oxygen	1.0	6.0	6.0
All other characteristics normal			0.0
Sickness-at-admission score			36.0
Changes in Laboratory Ordering and Recording over Time[c]			
30-day sickness-at-admission score	28.5	1.0	28.5
Missing data about ambulation before admission	1.0	8.0	8.0
Patient was recently hospitalized, and admission is in the post-PPS period.	4.0	–0.02	–0.08
Adjusted (30-day mortality) sickness-at-admission score			36.42

[a] We use the item score from Table 3.2 and the 1985–1986 multiplier and intercept of 0.082 and –4.22 (from Table 3.3) to estimate that patient A has a 13.2 percent probability of dying within 30 days postadmission, as follows:

$(28.5 \times 0.082) - 4.22 = -1.88$, the logit of dying, and
$\exp(-1.88)/[1 + \exp(-1.88)] = 13.2$ percent.

[b] The predicted 180-day postadmission death probability is 31.1 percent, using the Table 3.6 multiplier and intercept as follows:

$(36.0 \times 0.069) - 3.28 = -0.796$, and
$\exp(-0.796)/(1 + \exp(-0.796)) = 31.1$ percent.

Item score is from Table 3.2 and weight is from Table 3.6.

[c] Analysis of changes in laboratory ordering and recording practices showed that adjustments to the 30- and 180-day sickness-at-admission measures should be made for comparisons over time. For example, for hip fracture patients, missing creatinine added 2 points to the 30-day sickness-at-admission scale, and missing blood gases subtracted 2 points (i.e., because patients with missing blood gases were healthier on average than those with measured normal blood gases), and the recording-sensitive part of sickness at admission for hip fracture patients (the coma score and the three history variables) needed to be reduced by 0.18 in the post-PPS period to adjust for increases in recording. The recording adjustment, here –0.08, applies only to admissions in the post-PPS period. This patient is assigned a predicted 30-day probability of dying of 19.9 percent, using the Table 3.5 multiplier and intercept:

$(36.42 \times 0.095) - 4.85 = -1.39$,
and $\exp(-1.39)/[1 + \exp(-1.39)] = 19.9$ percent.

Item score is from above and weight is from Table 3.5.

Table 3.5

WEIGHTS FOR MISSING VARIABLES AND RECORDING ADJUSTMENTS USED FOR COMPARISONS OVER TIME

	Weights				
Variable	CHF	AMI	PNE	CVA	HIP
	30-Day Adjustments				
30-day scale	1***	1***	1***	1***	1***
Missing creatinine	4	2	3	2	2
Missing arterial pH			-0.5	-3	-2
Missing temperature		16*			
Missing bilirubin		7**			
Missing chest X-ray				3	
Missing ambulation data			8*		
Study multiplier[a]	0.107	0.085	0.095	0.114	0.121
Study intercept[a]	-3.45	-3.33	-4.85	-4.04	-4.10
Recording adjustment[b]	0	-0.07	-0.02	-0.04	-0.18
	180-Day Adjustments				
180-day scale	1***	1***	1***	1***	1***
Missing ambulation data	2*		2		
Missing chest X-ray		3			
Study multiplier[a]	0.087	0.068	0.078	0.091	0.091
Study intercept[a]	-2.13	-3.33	-3.82	-3.42	-3.26
Recording adjustment[c]	0	-0.07	-0.07	0	-0.04

NOTE: Significance is shown by asterisks: * = 3 < | t | < 5, ** = 5 < | t | < 7, and *** = | t | > 7.

[a] These multipliers and intercepts convert the adjusted sickness-at-admission score to the predicted probability of dying for the whole study, assuming average care.

[b] Applies to all recording-sensitive variables in Table 3.3 in the post-PPS period.

[c] Applies to all variables in Table 3.6 (except the 30-day score) in the post-PPS period.

remaining variables were disease-specific, but some, such as SGOT and myocardial infarction location for myocardial infarction patients, or cerebral infarction type for cerebrovascular accident patients, were nevertheless quite important predictors. Table 3.6 shows the sickness-at-admission variables that determine 180-day

Variables with large coefficients (i.e., t-values from the regression between 2 and 3), such as diseases of the thorax for pneumonia patients, represent rare conditions. In these data, they were strongly related to poor prognosis, but they may not be as useful in group adjustments as conditions that are more frequently present at admission.

Table 3.6 shows the sickness-at-admission variables that determine 180-day mortality. The 180-day mortality scales are the sum of the 30-day mortality scales and additional variables. (Table 3.4 shows how predicted 180-day mortality is computed.) The 30-day mortality scales are the most important part of the 180-day mortality scales, both because 180-day mortality includes 30-day mortality and because many variables that influence short-term mortality have prognostic value over the longer term as well.

Age, functioning, and chronic conditions are important as predictors of longer-term mortality: Prior nursing home residence, age, and the APACHE chronic health evaluation are

Table 3.6

WEIGHTS FOR SICKNESS-AT-ADMISSION VARIABLES THAT PREDICT DEATH WITHIN 180 DAYS AFTER ADMISSION

Variable	Observed Range	Weights[a]				
		CHF	AMI	PNE	CVA	HIP
30-day scale	98	1***	1***	1***	1***	1***
Age standardized	40			0.15	0.2	0.35*
APACHE CHE	1	4			7	10*
CHF by chest X-ray	3				2	
BUN standardized	9	4**	4			
Male	1	2*				3
From nursing home	1	4	6		6	6*
Mean blood pressure	4	-1*				
Serum creatinine	4					2*
Oxygenation	4		1			
Coma score	5					0.8
Cardiac disease[b]	6.4		3**			
Serum albumin	3				4*	
Infarction type	4				-2	
Prior hospitalization	1	3*				
Difficulty with limbs	1	4				
Noncompliance	1	-5				
Use of ventricular depressants	1	-5				
Antiarrhythmic medicine	1	4				
Prior CHF	1		6*			
Prior valve disease	1		8		6	
Prior diabetes	1		6			
Malnutrition	1				6	
Nonambulatory day 1					7	
Nonambulatory (before admission)	1			6		
Prior cancer score	3			4*		
New lung cancer	1			24*		
Home oxygen	1			6		
RAND comorbidity scale	16			1*		1*
Prior renal failure	1					-18
Pneumonia by chest X-ray	1					-6
1985–1986 multiplier		0.086	0.065	0.069	0.089	0.079
1985–1986 intercept		-2.10	-3.12	-3.28	-3.27	-3.12
1985–1986 180-day postadmission mortality		0.320	0.359	0.313	0.342	0.152

NOTE: Significance is shown by asterisks: No asterisk shows 2 < | t | < 3, * = 3 < | t | < 5, ** = 5 < | t | < 7, and *** = | t | > 7.

[a] Logistic regression coefficients were rounded to simple multiples of the 30-day score coefficient.

[b] Age, cardiomegaly, pulmonary congestion, and history of ischemia.

important predictors for at least three diseases. Most of the other additional variables relate to chronic problems, such as a history of congestive heart failure, cancer, and other comorbidities.

Predictive Power of the Sickness Scales

Table 3.7 presents conservative estimates of the predictive power of the RAND sickness-at-admission measures for each of the five diseases and compares them to the predictive performance of other measures of sickness at admission. In particular, we examined the APACHE II APS scale, which uses the same scoring and weighting of the items for all diseases; the APACHE variables with rescaled blood pressure, BUN, coma, and disease-specific weights (lines 3 and 4 of Table 3.7); and the scales used in the MMPS. Age-sex adjustment does not explain much of the variance in 30-day mortality in patients 65 and older. The addition of the generic APACHE APS adds to explanatory power, but the power of the APACHE variables is increased if they are reweighted specifically for each disease. The big increases in prediction for AMI and CHF are mainly due to the increased weight on rescaled systolic blood pressure. A simple count of diseased body systems added nothing to the predictive power of the reweighted APACHE variables, except for pneumonia, where R-squared rose from 21 to 23 percent, and hip fracture, where R-squared rose from 3 to 5 percent. The complete RAND measures offer further improvement. The RAND measures explain about one-quarter of the variance in 30-day mortality at the patient level for patients with either a myocardial infarction, pneumonia, or cerebrovascular accident. These values are better than those for MMPS, the best available sickness-at-admission scoring system before ours for Medicare patients, except for congestive heart failure.

Table 3.8 shows the 30- and 180-day postadmission mortality of those rated healthiest and sickest by the RAND sickness-at-admission scale. For each disease, there are clinically meaningful differences between the healthiest and sickest quartiles. For example, of those whose admission characteristics put them in the healthiest 25 percent of cerebrovascular accident patients, 3 percent died in the 30 days following admission, whereas 55 percent of the quartile of cerebrovascular accident patients that were sickest at admission died (a relative risk of 20.0; 95 percent confidence limits, 12.6 - 31.7). The 180-day prognosis contrasts are almost as large: 4 percent of pneumonia patients in the healthiest quartile died, as opposed to 68 percent of those in the sickest quartile (a relative risk of 16.5; 95 percent confidence limits 11.3 – 23.9).

Table 3.7

PERCENTAGE OF VARIANCE EXPLAINED BY SICKNESS-AT-ADMISSION SCALES FOR DEATHS WITHIN 30 DAYS AFTER ADMISSION

Predictor	CHF	AMI	PNE	CVA	HIP
Age, sex	1	2	3	2	1
Age, sex, APACHE II APS	3	12	18	17	3
Reweighted APACHE II APS[a]	10	18	21	26	3
Reweighted APACHE II APS and body system count[a]	10	18	23	26	5
MMPS[a,b]	15	14	18	25	—
RAND 30-day scale[a]	12	22	26	30	6

[a] R-squared computed in conservative way (see the text).

[b] Values computed on different but comparable datasets.

Table 3.8

30-DAY AND 180-DAY POSTADMISSION MORTALITY, BY SICKNESS-AT-ADMISSION QUARTILE FOR FIVE DISEASES
(In percent)

Quartile[a]	CHF	AMI	PNE	CVA	HIP	Five Diseases
30-Day						
Healthiest quartile	5	9	1	3	1	2
Middle quartiles	9	17	9	13	4	10
Sickest quartile	32	55	45	55	10	43
Overall	14	24	16	21	5	16
180-Day[b]						
Healthiest quartile	11	11	4	9	3	7
Middle quartiles	29	28	22	29	14	24
Sickest quartile	61	70	67	72	34	64
Overall	32	34	29	35	16	29

[a] Sickness-at-admission quartiles were determined by rank ordering patients according to their sickness-at-admission scores. RAND 30-day scale used.

[b] RAND 180-day scale used.

Pre- and Post-PPS Comparisons

Finally, applying our sickness-at-admission measures to data collected before and after the introduction of prospective payment indicated that sickness at admission increased significantly post-PPS (Table 3.9). In this table, sickness at admission is expressed as the probability of dying either 30 or 180 days postadmission for patients in each period who

Table 3.9

SICKNESS AT ADMISSION: PRE-PPS (1981–1982) COMPARED WITH POST-PPS (1985–1986)
(In percent)

	Expected Mortality[a]					
Sickness at Admission	CHF	AMI	PNE	CVA	HIP	Five Diseases
30-Day Scale						
Pre-PPS	13.6	23.5	14.2	20.6	4.6	15.4
Post-PPS	13.9	24.8	17.1	20.6	5.2	16.4
Difference (post – pre)	0.3	1.3	2.9***	0.0	0.6**	1.0**
180-Day Scale						
Pre-PPS	32.2	33.2	26.2	34.9	15.6	28.5
Post-PPS	32.8	35.3	30.7	34.7	16.8	30.1
Difference (post – pre)	0.6	2.1*	4.5***	–0.2	1.2*	1.6***
Sample sizes	2,591	2,588	2,536	2,565	2,541	12,821

NOTE: Significance of pre- and post-PPS differences is shown by asterisks: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$.

[a] Expected mortality based on sickness at admission, assuming average inhospital processes of care over the entire study.

received average processes of care (as defined by the pre-PPS and post-PPS samples combined). To facilitate comparison with the changes in postadmission mortality reported in Sec. VII, the sickness measures are averaged only on the 92.5 percent of patients for whom we have follow-up data on mortality. (Results on the full sample are almost identical.) For all five diseases combined, the 30-day mortality to be expected from sickness at admission was 1.0 percentage points higher in 1985–1986 (16.4 compared with 15.4 percent, $p < 0.01$ by a t-test), and the expected 180-day mortality was 1.6 percentage points higher (30.1 compared with 28.5 percent, $p < 0.001$). Pneumonia patients had the biggest increase over time in expected mortality from sickness at admission (a rise of 2.9 percentage points of expected 30-day mortality and 4.5 percentage points of 180-day mortality, $p < 0.001$), whereas the expected mortality resulting from admission sickness for cerebrovascular accident patients changed over time only slightly. If we had not used our adjustments for changes in laboratory ordering and recording, both the post-PPS values and the increases in sickness post-PPS in Table 3.9 would have been an additional 0.6 percentage points of expected mortality higher than the indicated values (e.g., 1.6 percentage points of expected 30-day mortality and 2.2 percentage points of expected 180-day mortality for all diseases combined).

Are the Effects of Sickness at Admission Stable over Time?

Although the medical record, unlike the ICD-9 codes that are used to determine the DRG, is not used to determine payments directly, there are influences (changes in medical culture, fear of litigation) that may be pushing hospitals to more thorough recording. We tested whether differences in recording could be responsible for part of the apparent increased sickness at admission directly through our comparison of recording-sensitive compared with recording-insensitive sickness variables. We looked at interactions of the effects of sickness at admission on mortality with PPS time period to see if adjustments for recording went far enough. The idea is that if the additional sickness coded is spurious, the "sicker" people will have lower mortality in the post-PPS period than in the pre-PPS period when they were really sicker. However, there is an alternative explanation of any such effect: Medical progress may be concentrated where the potential gains are the largest (i.e., on patients who before the progress were most likely to die).

Table 3.10 gives the results of the simplest such tests: regressions of mortality 30 days postadmission on sickness, post-PPS, and the interaction between post-PPS and sickness. The first column shows the results of a test of whether the relationship was significantly different over time. Only for pneumonia was the interaction of severity and post-PPS significant with mortality falling slightly more for sicker patients than for healthier. The next two columns show the coefficient of sickness at admission in a logistic regression of 30-day postadmission mortality (the difference between the two columns is the coefficient of the interaction). The changes in coefficients over time are quite small as a proportion of the continuing size, reflecting the stability of the relationship between sickness and death.

To understand how this affects our estimates of the change in outcomes over time, let s denote sickness at admission and suppose simply that

$$\begin{aligned}\text{Mortality} &= B + bs \text{ in the pre-PPS period, and}\\ &= A + as \text{ in the post-PPS period}\\ &= (A + B)/2 + (a + b)s/2 \text{ using the pooled data.}\end{aligned}$$

Table 3.10

EFFECTS OF CHANGES IN RELATION BETWEEN SICKNESS AND MORTALITY OVER TIME

Diseases	t for Interaction	Logistic Regression Coefficient Pre-PPS	 Post-PPS	Increase in Mortality Expected from Sickness Using Pre	 Using Post
Congestive heart failure	–0.56	0.110	0.102	0.3	0.3
Acute myocardial infarction	–0.22	0.086	0.085	1.3	1.3
Pneumonia	–2.57	0.111	0.086	3.3	2.6
Cerebrovascular accident	0.24	0.113	0.115	0.0	0.0
Hip fracture	–1.47	0.146	0.109	0.8	0.6
Five diseases	–1.64	—	—	1.14	0.96

If average sickness increases by Δs, then we have used the pooled correction factor = (Δs)(a + b)/2 to adjust outcomes for changes in sickness at admission.

The last two columns of Table 3.10 show how different the results would be if we used the pre- or the post-PPS period relationships between sickness and mortality to adjust. The changes are small either because sickness did not change much (as in cerebrovascular accident) or the coefficients did not change much (as in acute myocardial infarction). Only for pneumonia were both the change in sickness and the change in the coefficients large. Overall the changes in mortality expected from changes in sickness are ± 0.1 percent of those given in Table 3.7.

Although it makes no difference for this study, we think that even if the effects of severity had changed over time, it is correct to adjust outcomes for sickness using a relation derived from pooling the data, as a compromise between using either pre- or post-PPS data.

Here is an example to bring out the issue. Suppose in 1986 physicians knew how to treat some comorbid problem that was fatal in 1981. If the comorbid problem was part of the severity scale, our adjustments will show this as better outcomes for a very sick group of patients: If the new treatment was not in our process measure, the better outcomes would not be explained by process (and in the text we would say they may be due to medical progress). This is an extreme case, but if care is improving over time, it will have to show up in some groups of patients. If we adjust for severity in pre- and post-PPS patients separately, we cannot say what happened to severity or outcomes over time. This example shows that we must be careful to say that all changes may not be due to PPS, but that it is best to control as we did.

The differences between the estimated effects including interactions in the last two columns of Table 3.11 and the second row of Table 7.2 in Sec. VII are very small. The combined effect of including the interactions in the model for all diseases was to increase the difference from pre- to post-PPS 30-day mortality from the 1 percent we report in Sec. VII to 1.1 percent. However, because of the difficulties in explaining (and understanding) results including interactions, it is often preferable to report models without interactions, as presented elsewhere.

Table 3.11

STABILITY OF THE EFFECT OF MEASURED SICKNESS AT ADMISSION ON 30-DAY POSTADMISSION MORTALITY

			Logit Regression Coefficients			Predicted 30-Day Mortality	
Disease	n	Mean Sickness-at-Admission Scale	Post-PPS[a]	Sickness at Admission	Interaction[b]	Pre-PPS	Post-PPS
Congestive heart failure	2,591	32.38	−0.165	0.110	−0.007	15.1	13.0
			(−1.2)	(11.06)	(−0.56)		
Acute myocardial infarction	2,588	25.299	0.008	0.086	−0.002	24.2	24.2
			(0.07)	(13.88)	(−0.21)		
Pneumonia	2,538	26.733	0.212	0.111	−0.025	16.4	15.8
			(1.26)	(14.32)	(−2.57)		
Cerebrovascular accident	2,565	19.546	−0.14	0.113	0.002	21.3	19.9
			(−1.04)	(15.28)	(0.24)		
Hip fracture	2,541	7.31	−0.034	0.146	−0.037	5.4	4.6
			(−0.16)	(7.31)	(−1.47)		

[a] Numbers in parentheses are t-statistics.

[b] Interaction between post-PPS period and sickness-at-admission score.

DISCUSSION

Apart from the MMPS (Daley et al., 1988), previous scales to measure sickness at admission (1) have most often been applied to patients hospitalized in the intensive care unit, (2) are based on data collected at any time during the admission, (3) are not easily generalizable, or (4) are based on variables and algorithms that are not in the public domain. The sickness-at-admission scales presented here were developed from a large nationally representative sample of more than 14,000 patients with one of five diseases at a representative set of 297 hospitals. They are publicly available and could be used at either the individual patient level or the hospital level. For example, a physician caring for a patient with one of these five conditions could compute our sickness-at-admission value to find whether the predicted death probability for this patient was 5 or 50 percent. Hospitals that differ in their proportion of healthy and sick patients will have different outcomes independent of the care they provide; our scales can help to remove this confounding factor in hospital comparisons.

Our results have implications for those who want to use APACHE APS or MMPS. We found the APACHE II variables to be important in predicting death for all patients, whether they are hospitalized in or out of an intensive care unit. Except for blood pressure and renal failure, the APACHE variables were appropriately scaled and weighted. Low systolic blood pressure was an important predictor of death for all five diseases; but in contrast to APACHE's result on intensive care unit patients, high values of blood pressure were more favorable than normal values, especially for patients with either congestive heart failure or myocardial infarction, and reweighting for each disease led to much better predictions. BUN was important even after accounting for serum creatinine values (APACHE measures renal failure primarily by creatinine). In addition, we identified additional laboratory findings, e.g., SGOT and serum albumin, that were important predictors for particular diseases.

Our scales combine the acute data that are the focus of MMPS with an inventory of chronic morbid and comorbid disease markers. By using additional data our predictive results are usually better than those of MMPS. Our results confirm earlier findings that chronic comorbidity is important for predicting longer-term outcomes (Charlson et al., 1987; and Clemens et al., 1986). Chronic problems were also important for predicting inhospital and 30-day mortality, especially for pneumonia and hip fracture patients.

Unlike MMPS, we did not adjust for the assignment of a DNR order or for metastatic cancer, which in MMPS were strong predictors. We did not use DNR at admission as a predictor because of the possibility that the large increase in the use of DNR orders from 1981 to 1986 might have been due in part to new financial incentives. Patients with known metastatic cancer were excluded from our study to avoid the need to develop a separate set of process criteria for them. We could have raised predictive power by including these patients and adjustments.

The decision about which sickness-at-admission measures to use depends on the level of clinical data one is willing to collect: none, APACHE variables, a few other important disease-specific findings, or a more extensive inventory. Whether it is worth the cost to collect additional clinical variables routinely as part of the enormous administrative datasets compiled by HCFA is an important area for further study. On the basis of work reported here, to strengthen the mortality models that HCFA uses for its annual hospital mortality reports (HCFA, 1987), we would first add data on initial systolic blood pressure, and perhaps the few most important laboratory variables.

Our research demonstrates that the number of variables (from the medical record) important in measuring sickness at admission is limited. We began with an average number of 73 sickness variables per disease, but our final models for sickness measures that predict 30-day postadmission mortality contained an average of 19. Our research also shows the advantage of using disease-specific sickness-at-admission scales: The predictive power of disease-specific scales is noticeably higher than that of generic scales (Table 3.7).

Many variables that are individually strongly associated with death are not part of our final scales. Such variables were rejected for at least one of three reasons: redundancy, rareness, or slow effects. When several variables measure a similar concept, the scale includes the one with the most predictive power and often excludes the others. For example, current laboratory measures of renal failure overshadow prior renal failure, except for hip fracture patients. Some variables are just too rare to have a statistical impact on death. For example, meningitis at admission is known to be dangerous for pneumonia patients, but with just two of the 2,749 pneumonia patients in our sample having this problem, we cannot estimate precisely how dangerous it is. Finally, high diastolic blood pressure could have deleterious long-range effects, but even at 180 days after admission, the long-range harms were overshadowed by the short-range benefits for our sample of elderly patients.

In this study, we had to face the problem of differences in recording and laboratory ordering styles among hospitals and over time. This must be faced in any comparative study where such differences are expected. Each comparison requires a study of recording and laboratory ordering practices and appropriate adjustment. We have provided one (conservative) way to do this.

We have shown that patients were sicker in the period following implementation of prospective payment. This increased sickness must be taken into account in evaluating the changes in posthospital-admission death rates over time (e.g., if the processes of care were equally good, the expected mortality in the later period would be higher). Because hospitals, following introduction of prospective payment, had financial incentives to hospitalize less sick patients, the apparent increase in sickness is initially puzzling. We have adjusted for increases in laboratory ordering and recording of comorbidity, so they cannot explain the rise. Age is significantly higher, and vital signs at admission are significantly worse, for myocardial infarction, pneumonia, and hip fracture patients, indicating that these patients are really sicker at admission.

So why are hospitalized patients sicker on average than they used to be? Two explanations are possible: Better paramedical services keep more sick people alive to be hospitalized, and well people are being treated as outpatients. For acute myocardial infarction patients, it may reflect more aggressive prehospital treatment that keeps more sick patients alive to reach the hospital. In general, financial incentives to increase admission of less sick patients may be less important than were (1) activities of PROs, (2) increased review of appropriateness of hospitalizations, and (3) shifts from inpatient to outpatient settings for treatment. Hospital admissions have fallen, despite the financial incentives, and these other trends may have prevented the hospitalization of many not-so-sick patients, leaving a sicker population in the hospitals.

In summary, we have developed sickness-at-admission measures for five diseases that account for one-third of all hospital deaths in the Medicare population. These measures are disease-specific, in the public domain, and explain about one-quarter of the variance in death at the patient level following hospitalization for acute myocardial infarction, pneumonia, or cerebrovascular accident. If more explanatory power is desired, then a data source other than the medical record will be required (e.g., data collected prospectively from patients or physicians). Our sickness measures demonstrate a more than tenfold variation in actual death rates between the upper and lower quartiles of patients with each disease, and we should consider how such information can be used to improve clinical decisions. Finally, we show that increases in sickness at admission accompanied the unexpected drop in admissions following the introduction of prospective payment.

IV. MEASURING QUALITY OF CARE WITH EXPLICIT PROCESS CRITERIA BEFORE AND AFTER IMPLEMENTATION OF THE PPS

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Processes of care—what we do to patients—have been considered an essential component of quality of care measurement for over 50 years (Donabedian, 1966). Even if outcomes of care—what happens to patients—are the most meaningful measures of quality to the patient, we will be unable to develop clinical methods to improve outcomes unless we understand how processes and outcomes are related. Assessing quality of care by process also provides some measurement advantages over studying outcomes alone. Processes are more sensitive measures than outcomes because, in most clinical situations, not all patients who experience poor process of care suffer a poor outcome. For example, the quality of prescribing would be more easily measured through process evaluations of the use of chloramphenicol than by the occurrence of rare outcomes such as aplastic anemia and death that may follow its use. In addition, outcome measures are more affected by differences in patient sickness than are process measures.

Process can be measured either implicitly (no preset standards or criteria) or explicitly (Brook and Appel, 1973). In the past, it has proven difficult to demonstrate relationships between outcomes on the one hand and implicit or explicit assessments of process on the other, despite much important work in this field (Wyszewianski, 1988; McAuliffe, 1978; Rubenstein et al., 1977; and Greenfield et al., 1981). In the absence of such evidence, interest in results of process analyses has decreased. At present, despite hundreds of studies that examine the process of care provided to hospitalized patients with common conditions, it is impossible to find a library that contains disease-specific sets of process criteria, let alone validated criteria, by which, for example, the process of care given to a patient with a myocardial infarction can be evaluated.

The purpose of this section is twofold. First, we report on our attempt to develop a set of validated process criteria for elderly patients admitted to the hospital with one of five common conditions. By validated we mean that an established relationship exists in which process predicts outcome. Second, we apply the validated process criteria to patients treated before and after the implementation of PPS to determine if PPS has been associated with changes in the processes of care.

METHODS

Sample

We based our evaluation of the processes of care on the sample described in Sec. II. Demographic characteristics of the study sample and the details of the sampling plan are also described in Sec. II.

Developing Process Criteria

We sought process measures that were clinically valid. We began our search with a literature review and consultation with experts. We specifically asked the experts to define process measures that they believed made a difference in patient outcomes. These measures were then presented to disease-specific panels consisting of 5–12 generalist and specialist physicians, who were selected by our collaborators in this study, the PROs from the five states in which the study's sampling occurred. Each panel reviewed the suggested criteria to decide (1) whether as a group they believed that these criteria were likely to be reliably recorded in the medical record in 1981 as well as in 1986, and (2) whether the criteria made clinical sense. We paid particular attention to physicians' comments suggesting that variations in recording of process or use of technologies would be likely to occur by year, state, or hospital type. Process criteria vulnerable to such variations were excluded from the study.

After developing process measures that appeared to be clinically valid, we then pilot-tested whether they could be reliably assessed using the medical record as the database. For example, the number of times a frail patient was moved from the bed to a chair was not easily measured from the record and was not included as a process measure. Similarly, neither the time it took for a nurse to respond to a bedridden patient's call nor the adequacy of nutrition during the hospital stay could be assessed from the record. On the other hand, indications for use of the intensive care unit, medications, and procedures could be assessed from the medical record, and these were included. Finally, when the panel believed that there were several equally good strategies for diagnosing or treating a patient, we designed the process criteria to assign credit if any of the strategies were followed. (Appendix C provides additional material about the model used for developing explicit process criteria.)

Collecting Process Data

We developed disease-specific abstraction forms to collect the medical record data. In addition to studying some process measures that were applicable to all diseases, we studied some aspects of process in more detail for each disease. To accomplish this we collected data on approximately 100 process criteria for each disease (see Table 4.1). The instruments for measuring process have been published elsewhere (Kahn et al., 1988b; Rubenstein et al., 1988; Kosecoff et al., 1988; Sherwood et al., 1988; and Roth et al., 1988).

We extracted process data from the medical record in a way that reflected the temporal realities of the hospital stay. We defined the initial part of the hospital stay as the first two days, because patients admitted late in the day may receive some or all of their initial process on the second hospital day. For all five study diseases we collected process data on the first two hospital days; the first time a clinical problem arose regardless of the hospital day; and the day before and day of discharge. For the four medical diseases, we also studied process of care on hospital day 3. For patients with hip fracture we collected data on the days surrounding surgery.

Some process measures must be performed on a certain day to be appropriate; other process measures can take place at any time during the hospital stay. For example, if the patient had a fever, we collected data about whether a fever work-up was performed during the 72 hours surrounding the first febrile episode regardless of when, during the hospital stay, the fever occurred. Appendixes A-D present a complete list of process criteria for the five study diseases.

Table 4.1

COMPONENTS OF INHOSPITAL PROCESS MEASURED FOR EACH DISEASE

Component	CHF	AMI	HIP	PNE	CVA
Diagnostic Services					
Physician cognitive assessment	X	X	X	X	X
Nurse cognitive assessment	X	X	X	X	X
Venous blood tests	X	X	X	X	X
Arterial blood tests	X	X	X	X	X
X-ray	X	X	X	X	X
EKG	X	X	X	X	X
Microbiology	X		X	X	
Pathology					
Monitoring with ICU or telemetry	X	X	X	X	X
Therapeutic Services					
Medications	X	X	X	X	X
Oxygen therapy	X	X		X	X
Ancillary services (e.g., physical, respiratory therapy)			X	X	X
Therapeutic services (e.g., surgery)		X	X		X

Scoring Process Criteria

Process criteria were assigned points by consensus on the basis of the judgment of three study physicians. The assignment of points was made after a thorough review of the literature and after consultation with subspecialty experts. First, we identified the patients to whom a given criterion applied. For example, the use of the intensive care unit for a patient with congestive heart failure was not considered indicated for patients who were not severely ill (see Table 4.2). Second, we used clinical judgment to assign scores (points) to each process criterion based upon how likely a patient's outcome was to benefit from a given intervention. For the physician cognitive scales, which consisted of 8–12 dichotomous process criteria (depending on the disease), all process criteria were considered equally likely to benefit patient outcome. Thus, all physician cognitive process items were assigned a single point. However, for other process scales, points varied according to anticipated benefit for the patient. For example, use of the intensive care unit for very sick patients was worth 7 points, whereas use of the intensive care unit for a moderately sick patient was worth 3 points. Third, the process scores were developed to take account of the different clinical value of using the optimal intervention, a suboptimal intervention, or no intervention. Very sick patients received 7 of 7 points for use of the intensive care unit, 3 of 7 points for use of telemetry, and 0 of 7 points for no cardiac monitoring. The moderately sick patient was assigned 3 of 3 points for use of the ICU, 2 of 3 points for use of telemetry, and 0 of 3 points for no cardiac monitoring.

Table 4.2

SICKNESS LEVEL AND USE OF ICU OR TELEMETRY FOR PATIENTS HOSPITALIZED WITH CHF, 1981–1986

Level of Sickness on Day 3[a]	Monitoring Used	Day 3 Use of Monitoring (% of Patients)	Assigned Points	Applicable Points	Applicable Points (%)
Very sick	ICU or CCU	69	7	7	100
	Telemetry	12	3	7	43
	None	19	0	7	0
Moderately sick	ICU or CCU	43	3	3	100
	Telemetry	19	2	3	67
	None	38	0	3	0
Mildly sick	ICU or CCU	20		0	NA[b]
	Telemetry	23	0	0	NA
	None	57	0	0	NA

[a] Day 3 level of sickness is defined by a weighted sum of scores assigned for the presence of each of the following: shortness of breath (1 point); chest pain (1 point); confusion (2 points); heart rate ≥ 130 (2 points); respiratory rate ≥ 30 (2 points), systolic blood pressure < 90 (3 points); diastolic blood pressure ≥ 105 (1 point). Very sick = 7 or more points on this scale; moderately sick = 5–6; and mildly sick = 0–4.

[b] NA means that the process was not applicable to this patient given the patient's level of sickness.

Process Scales

Using clinical judgment we grouped process criteria according to the component categories in Table 4.1 and then tested our groupings by comparing them to those suggested by a Likert scale model. All process criteria in a Likert scale should measure a component of process common to all of the items on the scale but also measure independent error. The success of the Likert scale is evaluated by the interitem reliability, which depends on the criteria measuring a common concept, and the number of items in the scale (see Table 4.3 for interitem reliabilities) (Nunnally, 1978). These methods produced five conceptual process subscales and one overall process scale, as follows: physician cognitive; nurse cognitive; technical diagnostic; technical therapeutic; monitoring with ICU or telemetry; and overall process. The reliability of the overall scale is based on correlations of subscale scores rather than on correlations of individual subscale items.

In developing our process-scale measures we did not use the method of scale construction used in Sec. III. First, the relationships between process items and outcomes were much weaker than the relationships between process scales and outcomes. Second, we believe it was important to use clinical judgment about process to assure ourselves that we were measuring process not severity as a predictor of outcome. If we had used regression as a tool to study which process items were most important, we would likely have measured severity along with process, since the regression would be identifying the strongest predictors of mortality.

The physician diagnostic cognitive subscale measures the physician's performance as a gatherer of data about the patient's past medical history and current symptoms, and the performance of physical examinations during the hospital stay. The nurse diagnostic cognitive

Table 4.3

INTERITEM RELIABILITIES

Condition	Reliabilities[a]	
Congestive Heart Failure		
Overall Process Scale	0.50	
MD Cognitive Process Scale	0.64	
MD initial history		0.66
MD initial physical		0.50
MD physical day 2		(b)
MD history and physical day 3		(b)
RN Cognitive Process Scale	0.36	
RN initial examination		0.35
RN examination day 3		(b)
Technical Diagnostic Scale	0.56	
Use of chest X-ray and electrocardiogram day 1 and/or 2		0.40
Use of chest X-ray and electrocardiogram day 3		(c)
Use of venous blood tests (including CPK) and arterial blood gas day 1 and/or 2		0.81
Use of venous blood tests (including CPK) and arterial blood gas day 3		(c)
Use of cultures for febrile patients		(b)
Technical Therapeutic Scale	0.63	
Use of oxygen and digitalis therapy day 1 and/or 2		0.16
Use of oxygen and digitalis therapy day 3		(c)
Use of anticoagulant for nonambulatory patient		(b)
Monitoring with ICU/Telemetry Scale	0.94	
Monitoring with ICU/telemetry day 1 and/or 2		(b)
Monitoring with ICU/telemetry day 3		(b)
Acute Myocardial Infarction		
Overall Process Scale	0.63	
MD Cognitive Process Scale	0.67	
MD initial history		0.61
MD initial physical		0.52
MD history day 2		(b)
MD physical day 2		(b)
MD history and physical day 3		0.43
RN Cognitive Process Scale	0.65	
RN initial examination		0.48
RN examination day 3		0.24
Technical Diagnostic Scale	0.58	
Use of chest X-ray day 1 and/or 2		0.19
Use of chest X-ray day 3		0.41
Use of venous blood tests (including CPK) and arterial blood gas day 1 and/or 2		0.76
Use of venous blood tests (including CPK) and arterial blood gas day 3		0.76
Technical Therapeutic Scale	0.46	
Use of pressors and unloading agents day 1 and/or 2		0.44
Use of anti-arrhythmics day 1 and/or 2		0.74
Use of streptokinase day 1		0.10
Use of loop diuretics day 1 and/or 2		0.39
Use of chest pain medications day 1 and/or 2		0.15
Use of pacemaker for heart block day 1 and/or 2		(d)
Use of pressors and unloading agents day 3		(b)
Use of medication for high blood pressure day 1 and/or 2		(b)
Use of medication for high blood pressure day 3		(b)
Technical Diagnostic Scale	0.46	
Use of chest X-ray day 1 and/or 2		0.19
Use of chest X-ray day 3		0.41
Use of venous blood tests (including CPK) and arterial blood gas day 1 and/or 2		(b)
Use of venous blood tests (including CPK) and arterial blood gas day 3		0.76
Use of Swan-Ganz Catheter day 1 and/or 2		(b)
Monitoring with ICU/Telemetry Scale	0.93	
Monitoring with ICU/telemetry day 1		(b)
Monitoring with ICU/telemetry day 2		(b)
Monitoring with ICU/telemetry day 3		(b)
Pneumonia		
Overall Process Scale	0.40	
MD Cognitive Process Scale	0.32	
MD history day 1		0.64
MD physical day 1		0.48
MD physical day 2		0.39
MD examination day 3		0.37
RN Cognitive Process Scale	0.36	
RN initial examination day 1 and/or 2		0.31
RN examination day 3		(b)
Patient weight if not unstable		(b)
Technical Diagnostic Scale	0.58	
Use of chest X-ray and electrocardiogram day 1 and/or 2		0.0
Use of chest X-ray and electrocardiogram day 3		0.0
Use of venous blood tests (including CPK) and arterial blood gas day 1 and/or 2		0.80
Use of venous blood tests (including CPK) and arterial blood gas day 3		0.94
Initial use of cultures for patients with refractory fever		(b)
Technical Therapeutic Scale	0.86	
Change antibiotics if no response		(b)
Use antibiotics in a timely manner (nonimmunocompromised)		(b)
Use antibiotics in a timely manner (immunocompromised)		(b)
Use of venous blood tests (including CPK) and arterial blood gas day 1 and/or 2		(b)
Use of venous blood tests (including CPK) and arterial blood gas day 3		(b)
Use of oxygen therapy day 1 and/or 2		(b)
Use of oxygen therapy day 3		(b)
Monitoring with ICU/Telemetry Scale	0.91	
Monitoring with ICU/telemetry day 1 and/or 2		(d)
Monitoring with ICU/telemetry day 3		(b)
Cerebrovascular Accident		
Overall Process Scale	0.56	
MD Cognitive Process Scale	0.62	
MD history day 1		0.44
MD physical day 1		0.62
MD physical day 3		(b)
MD history day 2		0.66
MD history day 3		0.59
RN Cognitive Process Scale	0.42	
RN initial examination day 1 and/or 2		0.40
RN functional assessment		0.36
RN examination day 3		0.00
Technical Diagnostic Scale	0.55	
Use of chest X-ray/electrocardiogram day 1 and/or 2		0.50
Use of venous blood tests (including CPK) and arterial blood gas day 1 and/or 2		0.83
Use of venous blood tests (including CPK) and arterial blood gas day 3		0.69
Use of diagnostic neurologic study (e.g., EEG, CAT scan) day 1 and/or 2		(b)
Monitoring with ICU/Telemetry Scale	0.92	
Monitoring with ICU/telemetry day 1 and/or 2		(b)
Monitoring with ICU/telemetry day 3		(b)
Hip Fracture		
Overall Process Scale	0.33	
MD Cognitive Process Scale	0.55	
MD history day 1		0.31
MD physical day 1 and/or 2		0.48
RN Cognitive Process Scale	0.00	
RN initial examination		0.23
RN examination postoperative		(b)
Technical Diagnostic	(d)	
Use of chest X-ray and electrocardiogram day 1 and/or 2		0.56
Use of venous blood tests (including CPK) and arterial blood gas day 1 and/or 2		0.77
Use of venous blood tests (including CPK) and arterial blood gas day postop		0.80
If hip pinning, then periop hip X-ray		(b)
If hip arthroplasty, then periop hip X-ray		(b)
Use of perioperative hematocrit		(b)
Use of preoperative electrocardiogram		(b)
Use of postoperative chest X-ray, electrocardiogram		0.62
Monitoring with ICU/Telemetry Scale	(b)	
Monitoring with ICU/telemetry postoperative		0.94

[a] Interitem reliability is the square of the correlation between the sum of items and the underlying conceptual process value and is determined from the average correlation between items.

[b] Interitem reliability cannot be calculated because there is only one item in the scale.

[c] Reliability not available.

[d] Interitem reliability cannot be computed because items are not measured on the same patients.

subscale measures the nurse's performance as a gatherer of data about the patient's functional status, current symptoms, and vital signs during the hospital stay. The technical diagnostic process subscale measures use of diagnostic tests (e.g., venous laboratory studies, arterial blood gases, X-rays, and electrocardiograms) that are indicated given the patient's daily burden of illness. The technical therapeutic process subscale measures use of treatments (e.g., medication, surgery, and physical therapy) that are indicated given the patient's daily sickness level. The ICU or telemetry monitoring subscale evaluates the use of monitoring in patients as a function of their level of illness. Whereas both the physician and nurse cognitive subscales depend somewhat on styles of documentation in the medical record, the subscales for technical diagnostic, technical therapeutic, and monitoring with ICU or telemetry are much less so.

To produce these subscales, we had to combine some process measures that were applicable to all patients with those that were applicable to subsets of patients. Sicker patients and those with longer hospital stays had more applicable process criteria than did less sick patients. In general, compliance with criteria that were applicable only to sicker patients was lower than was compliance with those criteria that were applicable to all patients. To avoid a bias when combining criteria to form scales, we standardized all process criteria to have mean 0 and standard deviation 1. The overall scale was constructed using an average of each of the equally weighted five conceptual subscales in like manner. Using this method meant that each patient who received average process would have an expected process score of 0 and standard deviation of 1 regardless of the number of process score items that were applicable to the patient.

In summary, the overall process scale is constructed by taking the subscales, standardizing them, to mean 0 standard deviation 1, averaging the subscales, and restandardizing them to mean 0, standard deviation 1 for everyone in the sample regardless of what pattern of subscale scores were available to them.

To validate our process scales, we used logistic regression to examine the relationship between inhospital process-scale scores and mortality 30 and 180 days after admission, after adjusting for disease-specific sickness at admission. We also used logistic regression to determine the association of PPS with changes in process. Our methods for measurement of and adjustment for sickness at admission are described in Sec. III. (Additional background material about how explicit process measures were analyzed is reported in App. C.)

RESULTS

Reliability and Validity of Process Measures

As viewed by our physician panels, the process measures made clinical sense and were representative of important areas of inhospital processes of care (see Tables 4.13–4.17, below). (Also see App. C.) The item-level reliabilities in Table 4.3 are for the most part acceptably high (median 0.52). The intercorrelation of the subscales is about the same as the intercorrelation of the items within the subscales. That is, they are significantly greater than 0, but still low (e.g., 0.1–0.4).

Compliance was high for most of the explicitly stated process criteria (Tables 4.13–4.17, below), supporting the notion of content validity (Nunnally, 1978). However, for 21 percent of the congestive heart failure patients, 16 percent of the acute myocardial infarction patients, and 24 percent of the pneumonia patients, the presence or absence of a heart murmur was not noted in the medical record (Apps. A–D). For 19 percent of congestive heart failure patients, 26 percent of pneumonia patients, and 17 percent of cerebrovascular accident patients, fewer than three blood pressure readings were taken on day 2 of the hospitalization. Five percent of congestive heart failure patients, 6 percent of acute myocardial infarction patients, 9 percent of cerebrovascular accident patients, and 10 percent of pneumonia and hip fracture patients did not receive a serum potassium study on days 1 or 2 of the hospital stay. One-quarter of patients sick enough to be hospitalized for congestive heart failure did not have a serum creatinine study in the first two days, whereas one-third of the congestive heart failure patients admitted in a moderately or very sick condition did not have any creatinine phosphokinase enzyme studies to rule out an acute myocardial infarction on days 1 or 2 of the hospitalization.

A better test of the validity of process measures, however, is the documentation of a relationship between processes of care and outcomes. Toward this end we evaluated the relationship between the process scales and 30-day postadmission mortality. For this analysis, patients were ranked according to their process-scale scores. Patients labeled as having good process were in the top quartile (25 percent), and patients labeled as having poor process were in the bottom quartile (25 percent). For patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, and cerebrovascular accident, better process is significantly associated with lower 30-day postadmission mortality rates. For example, Table 4.4 shows that mean 30-day postadmission mortality, adjusted for sickness at admission, for patients hospitalized with congestive heart failure, is 11 percent for patients receiving good overall process, 13 percent for patients receiving medium overall process, and 19 percent for patients receiving poor overall process ($p = 0.0002$). The relative risk of adjusted 30-day death as process changed from good to poor was 1.74 (95 percent confidence interval 1.34 – 2.26; $p < 0.001$).

Table 4.4

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY ADJUSTED FOR SICKNESS AT ADMISSION AND OVERALL PROCESS FOR FIVE DISEASES PRE- AND POST-PPS COMBINED

(In percent)

	Overall Process Scale Score Category[a]				
Disease	Good Process	Medium Process	Poor Process	p-value[b]	Relative Risk as Process Changes from Good to Poor
Congestive heart failure	10.7	12.9	18.6	< 0.01	1.74 (0.23)[c]
Acute myocardial infarction	23.9	22.0	30.1	< 0.01	1.26 (0.11)
Pneumonia	14.8	15.2	20.2	< 0.01	1.36 (0.16)
Cerebrovascular accident	18.7	20.3	25.5	< 0.01	1.36 (0.14)
Hip fracture	5.1	5.2	4.6	> 0.05	0.90 (0.22)

NOTE: Adjustments for sickness at admission are made using the significant predictors of 30-day postadmission death status on days 1 or 2 of admission.

[a] Patients were ranked according to process scale scores. Patients with the highest 25 percent of process scale scores were assigned good process. Patients with the lowest 25 percent of process scale scores were assigned poor process. Other patients were assigned medium process.

[b] From tests of the significance of the process coefficients in the logistic regressions of mortality on process measured continuously, after adjustment for sickness at admission.

[c] Values in parentheses are approximate standard errors for relative risks.

For hip fracture patients we were unable to demonstrate a process-outcome link when outcome was defined as 30-day postadmission mortality. This occurred partly because only 5 percent of hip fracture patients died within 30 days. The relatively low mortality rate for hip fracture patients limits our power to detect a process-outcome relationship.

To ascertain whether the overall process-outcome relationship was maintained for the five conceptual scales that constitute the composite process scale, we examined the relationship between 30-day postadmission mortality, adjusted for sickness at admission, and each of the process scales for each of the five diseases (Table 4.5). A significant process-outcome relationship in the expected direction existed for four of the five scales for congestive heart failure, acute myocardial infarction, and pneumonia, and for three of the four scales for cerebrovascular accident. In all instances, we were unable to find a clinically sensible process-outcome link for the process scale based on monitoring with ICU or telemetry. We found one significant relationship between ICU/telemetry process and 30-day postadmission mortality for hip fracture, but it was in the unexpected direction (better process, worse outcome). Tables 4.6 through 4.11 show the relationship between each of the process scales and 30-day postadmission mortality stratified by sickness at admission quartiles.

Process of Care Pre- and Post-PPS

For each process scale for the five diseases, we found better process of care post-PPS than pre-PPS. Table 4.12 shows the amount of improvement in process scores post-PPS as compared with pre-PPS. In all instances the improvement was significant ($p < 0.05$) except for monitoring with intensive care unit or telemetry, where process changed significantly ($p < 0.05$) only for congestive heart failure and hip fracture. The post-PPS improvements in process were apparent both for process measures that could have been influenced by changes in recording in the medical record (e.g., physician and nurse cognitive) and for process measures that were unlikely to be affected by such potential biases (e.g., appropriate use of technical diagnostics and technical therapeutics). Table 4.12 also demonstrates the importance of the post-PPS improvements in process of care. For example, for congestive heart failure, we

Table 4.5

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY ADJUSTED FOR SICKNESS AT ADMISSION AND PROCESS SCALES[a] FOR FIVE DISEASES
(In percent)

	CHF		AMI		PNE		CVA		HIP	
Process Subscale	Good	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Physician cognitive	12	16*	23	28*	15	19*	18	24*	6	5
Nurse cognitive	11	17*	24	27*	15	19*	19	24*	4	6
Technical diagnostic	11	16*	24	29*	14	19*	19	25*	4	5
Technical therapeutic	11	21*	29	21+	15	21*	(b)	(b)	5	5
Monitoring with ICU/telemetry	18	13	21	28*	19	15	23	21	10	5+
Overall	11	19*	24	30*	15	20*	19	26*	5	5

NOTE: * $p < 0.05$ using a logistic regression of mortality (adjusted for sickness at admission) on process. + paradoxical $p < 0.05$: better process, worse outcome.

[a] Patients were ranked according to process-scale scores. Patients with the highest 25 percent of process-scale scores were assigned good process and patients with the lowest 25 percent of process-scale scores were assigned poor process.

[b] The technical therapeutics scale was not measured for CVA.

Table 4.6

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY AND OVERALL PROCESS STRATIFIED BY SICKNESS-AT-ADMISSION QUARTILE

(In percent)

	CHF Process[b]			AMI Process			PNE Process			CVA Process			HIP Process		
Sickness at Admission[a]	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good
Quartile I (least sick)	8	5	4	17	6	10	2	1	1	4	2	2	1	1	1
Quartile II	7	7	4	18	10	15	4	5	4	13	9	7	4	3	3
Quartile III	20	11	8**	22	21	19	19	12	14	22	17	17	5	5	5
Quartile IV (sickest)	40	29	28*	64	51	50**	55	44	40**	64	54	49**	7	11	11*

NOTES: * = upper quartile different from lower quartile, $p < 0.05$; ** = upper quartile different from lower quartile, $p < 0.01$; and *** = upper quartile different from lower quartile, $p < 0.001$.

[a] Sickness-at-admission quartiles are defined by ranking patients using the sickness-at-admission scales designed to predict death within 30 days of admission. See Sec. III. Quartile I includes the 25 percent of the patient sample with the least sickness at admission (lowest scores). Quartile IV includes the 25 percent of the patient sample with the most sickness at admission (highest scores).

[b] Process categories are defined by ranking patients using the process scores. The 25 percent of patients with the lowest scores are assigned poor process and those with the highest 25 percent of scores are assigned good process. The remaining 50 percent are assigned medium process.

Table 4.7

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY AND PHYSICIAN COGNITIVE DIAGNOSTIC STRATIFIED BY SICKNESS-AT-ADMISSION QUARTILE

(In percent)

	CHF Process[b]			AMI Process			PNE Process			CVA Process			HIP Process		
Sickness at Admission[a]	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good
Quartile I (least sick)	4	7	4	12	10	6	2	1	6	4	3	1	1	1	2
Quartile II	8	6	5	13	12	14	4	4	4	15	7	7*	3	4	4
Quartile III	14	11	12	24	20	20	18	12	15	18	18	18	5	6	4
Quartile IV (sickest)	37	32	26*	62	52	53	52	48	36**	59	58	45**	9	7	13

NOTES: * = upper quartile different from lower quartile, $p < 0.05$; ** = upper quartile different from lower quartile, $p < 0.01$; and*** = upper quartile different from lower quartile, $p < 0.001$.

[a] Sickness-at-admission quartiles are defined by ranking patients using the sickness-at-admission scales designed to predict death within 30 days of admission. See Sec. III. Quartile I includes the 25 percent of the patient sample with the least sickness at admission (lowest scores). Quartile IV includes the 25 percent of the patient sample with the most sickness at admission (highest scores).

[b] Process categories are defined by ranking patients using the process scores. The 25 percent of patients with the lowest scores are assigned poor process and those with the highest 25 percent of scores are assigned good process. The remaining 50 percent are assigned medium process.

Table 4.8

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY AND NURSE COGNITIVE DIAGNOSTIC STRATIFIED BY SICKNESS-AT-ADMISSION QUARTILE

(In percent)

	CHF Process[b]			AMI Process			PNE Process			CVA Process			HIP Process		
Sickness at Admission[a]	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good
Quartile I (least sick)	6	7	2	11	9	9	1	0	1	2	3	3	2	2	1
Quartile II	10	4	4*	17	12	13	5	4	4	13	8	6*	3	5	3
Quartile III	15	12	8*	22	20	20	17	13	13	20	19	14	6	6	4
Quartile IV (sickest)	37	28	28	59	53	53	53	44	39**	59	53	53	13	11	8

NOTES: * = upper quartile different from lower quartile, $p < 0.05$; ** = upper quartile different from lower quartile, $p < 0.01$; and *** = upper quartile different from lower quartile, $p < 0.001$.

[a] Sickness-at-admission quartiles are defined by ranking patients using the sickness-at-admission scales designed to predict death within 30 days of admission. See Sec. III. Quartile I includes the 25 percent of the patient sample with the least sickness at admission (lowest scores). Quartile IV includes the 25 percent of the patient sample with the most sickness at admission (highest scores).

[b] Process categories are defined by ranking patients using the process scores. The 25 percent of patients with the lowest scores are assigned poor process and those with the highest 25 percent of scores are assigned good process. The remaining 50 percent are assigned medium process.

Table 4.9

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY AND TECHNICAL DIAGNOSTIC STRATIFIED BY SICKNESS-AT-ADMISSION QUARTILE

(In percent)

	CHF Process[b]			AMI Process			PNE Process			CVA Process			HIP Process		
Sickness at Admission[a]	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good
Quartile I (least sick)	6	6	4	11	7	13	1	1	1	4	2	2	1	1	2
Quartile II	6	6	6	16	11	15	4	5	3	10	10	8	4	4	2
Quartile III	15	16	9*	25	19	18	16	15	12	24	15	17	4	7	4
Quartile IV (sickest)	35	38	26*	65	53	48***	53	47	38**	62	57	47**	12	11	9

NOTES: * = upper quartile different from lower quartile, $p < 0.05$; ** = upper quartile different from lower quartile, $p < 0.01$; and *** = upper quartile different from lower quartile, $p < 0.001$.

[a] Sickness-at-admission quartiles are defined by ranking patients using the sickness-at-admission scales designed to predict death within 30 days of admission. See Sec. III. Quartile I includes the 25 percent of the patient sample with the least sickness at admission (lowest scores). Quartile IV includes the 25 percent of the patient sample with the most sickness at admission (highest scores).

[b] Process categories are defined by ranking patients using the process scores. The 25 percent of patients with the lowest scores are assigned poor process and those with the highest 25 percent of scores are assigned good process. The remaining 50 percent are assigned medium process.

Table 4.10

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY AND TECHNICAL THERAPEUTIC STRATIFIED BY SICKNESS-AT-ADMISSION QUARTILE

(In percent)

	CHF Process[b]			AMI Process			PNE Process			HIP Process		
Sickness at Admission[a]	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good
Quartile I (least sick)	6	6	5	7	10	13*	1	1	1	1	1	1
Quartile II	10	10	5	8	15	21***	7	5	1*	4	4	3
Quartile III	20	20	10**	16	22	26	21	12	12*	5	5	6
Quartile IV (sickest)	44	44	24***	54	57	56	54	43	46	12	12	8

NOTES: * = upper quartile different from lower quartile, $p < 0.05$; ** = upper quartile different from lower quartile, $p < 0.01$; and *** = upper quartile different from lower quartile, $p < 0.001$.

[a] Sickness-at-admission quartiles are defined by ranking patients using the sickness-at-admission scales designed to predict death within 30 days of admission. See Sec. III. Quartile I includes the 25 percent of the patient sample with the least sickness at admission (lowest scores). Quartile IV includes the 25 percent of the patient sample with the most sickness at admission (highest scores).

[b] Process categories are defined by ranking patients using the process scores. The 25 percent of patients with the lowest scores are assigned poor process and those with the highest 25 percent of scores are assigned good process. The remaining 50 percent are assigned medium process.

Table 4.11

RELATIONSHIPS BETWEEN 30-DAY POSTADMISSION MORTALITY AND MONITORING AND ICU STRATIFIED BY SICKNESS-AT-ADMISSION QUARTILE

(In percent)

	CHF Process[b]			AMI Process			PNE Process			CVA Process			HIP Process		
Sickness at Admission[a]	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good	Poor	Med.	Good
Quartile I (least sick)	5	4	12*	9	36	9	1	1	1	2	2	2	1	1	1
Quartile II	6	15	6	14	25	12	3	19	11**	9	11	21	3	3	4
Quartile III	12	15	14	22	48	19	12	60	20*	17	37	20	4	18	18**
Quartile IV (sickest)	30	33	40*	66	93	43***	45	50	48	55	58	57	9	23	17

NOTES: * = upper quartile different from lower quartile, $p < 0.05$; ** = upper quartile different from lower quartile, $p < 0.01$; and *** = upper quartile different from lower quartile, $p < 0.001$.

[a] Sickness-at-admission quartiles are defined by ranking patients using the sickness-at-admission scales designed to predict death within 30 days of admission. See Sec. III. Quartile I includes the 25 percent of the patient sample with the least sickness at admission (lowest scores). Quartile IV includes the 25 percent of the patient sample with the most sickness at admission (highest scores).

[b] Process categories are defined by ranking patients using the process scores. The 25 percent of patients with the lowest scores are assigned poor process and those with the highest 25 percent of scores are assigned good process. The remaining 50 percent are assigned medium process.

Table 4.12

POST-PPS CHANGES IN PROCESS SCORES AND EXPECTED CHANGES IN MORTALITY ADJUSTED FOR SICKNESS AT ADMISSION
(In percent)

	CHF			AMI			PNE			CVA			HIP		
		Expected Change from Post-PPS Gains[b]			Expected Change from Post-PPS Gains[b]			Expected Change from Post-PPS Gains[b]			Expected Change from Post-PPS Gains[b]			Expected Change from Post-PPS Gains[b]	
Process Scale	Post-PPS Gains[a]	30-Day	180-Day	Post-PPS Gains	30-Day	180-Day	Post-PPS Gains	30-Day	180-Day	Post-PPS Gains	30-Day	180-Day	Post-PPS Gains	30-Day	180-Day
Physician cognitive	+0.31 *	–0.5	–0.7	+0.24 *	–0.7	–0.7	+0.24 *	–0.4	–0.5	+0.36 *	–0.8	–0.4	+0.16 *	+0.1[d]	–0.0[d]
Nurse cognitive	+0.36 *	–0.8	–0.6	+0.22 *	–0.6	–0.5	+0.42 *	–0.8	–1.3	+0.46 *	–0.8	–0.5	+0.31 *	–0.1[d]	0.3[d]
Technical diagnostic	+0.26 *	–0.4	–0.0	+0.21 *	–0.6	–0.5	+0.23 *	–0.4	–0.5	+0.25 *	–0.6	–0.4	+0.22 *	–0.0[d]	–0.2[d]
Technical therapeutic	+0.09 *	–0.2	–0.1	+0.16 *	+0.2[e]	+0.3[e]	+0.15 *	–0.3	–0.4	(c)	(c)	(c)	+0.29 *	–0.1[d]	–0.2[d]
Monitoring with ICU/ telemetry	+0.21 *	–0.2[d]	–0.9[d]	+0.05	–0.1	–0.1	+0.08	+0.1[d]	–0.0[d]	+0.08	–0.2[d]	–0.2[d]	–0.04 *	–0.1[e]	–0.2[e]
Overall process	+0.42 *	–1.2	–1.0	+0.27 *	–0.8	–0.7	+0.43 *	–1.0	–1.6	+0.49 *	–1.4	–1.0	+0.41 *	–0.0[d]	–0.4

NOTE: * = $p < 0.05$ for post-PPS gains in process scores.

[a] Entries represent the change in process scores from pre-PPS to post-PPS on a scale with mean 0 and standard deviation 1. A positive sign means that process of care was better post-PPS.

[b] Outcomes (mortality rates) are adjusted for sickness at admission. A minus sign in the mortality columns means that expected mortality dropped post-PPS.

[c] Technical therapeutic processes for CVA were not measured.

[d] The estimated change in mortality is included for completeness. However, the process-outcome link was not sufficiently strong for these process scales to accurately predict changes in mortality from changes in process of care.

[e] $p < 0.05$ for paradoxical process-outcome relationship: better process, worse outcome.

can use the previously demonstrated process-outcome link to translate the post-PPS gain in the physician cognitive process scale of 0.31 to an expected 0.5 percentage point reduction in 30-day postadmission mortality and an expected 0.7 percentage point reduction in 180-day postadmission mortality (see Table 4.12). For each disease except hip fracture, the post-PPS improvements in the overall process scale were associated with an expected reduction both in 30-day mortality (ranging from 0.1–1.4 percentage points) and 180-day mortality (with a range from 0.4–1.6 percentage points).

We also compared the strength of the process-outcome link pre-PPS compared with post-PPS. The process-outcome link was slightly and insignificantly stronger post-PPS for the overall scale ($p = 0.2$), physician cognitive scale ($p = 0.1$), nurse cognitive scale ($p = 0.1$), and the technical therapeutic scale ($p = 0.9$). The link was slightly and insignificantly weaker for the technical therapeutic scale ($p = 0.9$). It was not significant in either PPS period for the monitoring with ICU/telemetry scale.

These improvements in the process scales post-PPS are a direct result of improvements in the individual process items that constitute the scales (Tables 4.13 through 4.17). For example, for congestive heart failure patients, 58 percent had a documentation of a day 2 lung examination pre-PPS, compared with 71 percent post-PPS (App. A). For congestive heart failure, the fraction of patients for whom nurses documented at least three blood pressure readings on day 2 increased from 78 percent pre-PPS to 84 percent post-PPS. For all diseases the use of the electrocardiogram on admission to the hospital increased. The use of oxygen (or intubation) on day 1 for hypoxic patients (i.e., $pO2 < 60$) improved from 87 percent pre-PPS to 93 percent post-PPS (for congestive heart failure). Antibiotics for pneumonia patients were delivered more promptly, and a higher fraction of moderately and very sick patients received monitoring with ICU or telemetry. Additional data about performance on process criteria and scales pre- compared with post-PPS are shown in App. C.

DISCUSSION

We have attempted to demonstrate the validity of our process measures by studying face and content validity and by establishing process-outcome links. Validation by these methods supports the view that our explicit process criteria are indeed measuring important aspects of inhospital processes of care. If our process scores reflected only recording changes rather than what truly happened to patients, we would have been unable to find a statistically significant relationship between better processes of care and lower mortality. In addition, if we were measuring only improvements in recording post-PPS compared with pre-PPS, we would have expected to find improvements in process post-PPS only for process measures that depend heavily on recording (e.g., physician and nurse process). However, we have demonstrated a significant process-outcome relationship and improvements over time in all process scales, including both the recording-sensitive scales and those not likely to be sensitive to changes in recording practices.

Having developed a set of valid process measures, we compared processes of care pre- and post-PPS. Consistently across diseases and across types of process measures, we found processes to be better during the post-PPS period. Cognitive and technical services showed equivalent gains. The findings are especially notable since the process criteria are based upon concepts in medicine that have been well known for at least a decade, rather than upon new and evolving technologies.

Table 4.13

PROCESS CRITERIA FOR CONGESTIVE HEART FAILURE

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
All patients hospitalized for CHF	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:			
	Past surgical history	100	61	66
	Medication use immediately before admission	100	78	84
	Allergy history	100	51	58
	Alcohol use (or nonuse)	100	42	47
	Jugular veins examined	100	63	70
	Heart sounds examined	100	67	73
	Heart murmur examined (or not present)	100	78	80
	Abdomen examined	100	97	98
	Lower extremity examined for edema	100	91	92
	Lung examined day 1	100	99	98
	Lung examined day 2	100	58	71
All patients hospitalized for CHF	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:			
	Shortness of breath (presence or absence) day 1	100	88	93
	Shortness of breath (presence or absence) day 2	100	88	92
	Blood pressure assessment at least 3 times day 2	100	78	84
	Urinary continence (presence or absence)	100	65	72
	Ambulatory status	100	70	79
	Preadmission residence	100	92	95
All patients hospitalized for CHF	Within the initial two days of hospitalization, order:			
	Chest X-ray	100	94	96
	Electrocardiogram	100	87	91
All patients hospitalized for CHF	Within the initial two days of hospitalization, order each of the following laboratory studies:			
	BUN	100	88	93
	Creatinine	100	69	81
	Venous bicarbonate	100	80	87
	Sodium	100	93	97
	Potassium	100	93	97
	White blood count	100	92	94
	Hematocrit or hemoglobin	100	91	94
Patients moderately or very sick (i.e., ASCC[a] ≥ 5) day 1 or 2	Order cardiac enzyme study days 1 or 2 (e.g., CPK)	26	66	67
Patients moderately or very sick (i.e., ASSC ≥ 5) day 1 or 2	Obtain arterial blood gas days 1 or 2	26	72	78
Patients moderately sick (i.e., ASSC 5-6) day 1	Use the ICU day 1 or	16	43	46 ICU
	Use telemetry day 1		8	24 Telemetry
Patients moderately sick (i.e., ASSC 5-6) day 2	Use the ICU day 2 or	7	49	41 ICU
	Use telemetry day 2		13	31 Telemetry

Table 4.13—continued

		% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
If	Then		Pre-PPS	Post-PPS
Patients very sick (i.e., ASSC ≥ 7) day 1	Use the ICU day 1	6	61	71 ICU
	Telemetry not sufficient but preferable to no cardiac monitoring day 1		12	17 Telemetry
Patients very sick (i.e., ASSC ≥ 7) day 2	Use the ICU day 2	2	60	69 ICU
	Telemetry not sufficient but preferable to no cardiac monitoring day 2		10	22 Telemetry
Patients hypoxic (i.e., p02 < 60) on day 1	Use supplemental oxygen therapy or intubate day 1	18	87	93
Patients hypoxic (i.e., p02 < 60) on day 2	Use supplemental oxygen therapy or intubate day 2	4	90	91
Patients moderately or very sick (i.e., ASSC ≥ 5) day 1 and day 2 and arterial blood gases not evaluated on either day	Use supplemental oxygen therapy or intubate day 1 or 2	1	100	86
All patients hospitalized with CHF except those with systolic blood pressure < 90 day 1 and 2	Use loop diuretic or digitalis day 1 or 2	92	94	95
All patients hospitalized for CHF	On hospital day 3, the physician should document each of the following in the medical record:			
	Shortness of breath (presence or absence)	100	45	54
	Lung examination	100	60	69
All patients hospitalized for CHF	On hospital day 3, the nurse should document in the medical record:			
	Shortness of breath (presence or absence)	100	85	91
Patients moderately or very sick (i.e. ASSC ≥ 5) on day 3	Order a chest X-ray on day 3	7	41	29
	Order an electrocardiogram on day 3	7	46	32
Patients somewhat sick (i.e., ASSC 3-4) on day 3	Order at least three of seven venous blood studies on day 3 (e.g., venous bicarbonate, creatinine, BUN, sodium, potassium, white blood count, hematocrit)	16	38	54
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Order each of the following venous blood tests (e.g., venous bicarbonate, creatinine, BUN, sodium, potassium, white blood count, hematocrit)	7	14	16
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Order a cardiac enzyme study (e.g., CPK) day 3	7	28	18
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Obtain an arterial blood gas day 3	7	42	39

Table 4.13—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
Patients moderately sick (i.e., ASSC 5-6) on day 3	Use the ICU day 3 or use telemetry day 3	5	47 13	39 ICU 26 Telemetry
Patients very sick (i.e., ASSC ≥ 7) on day 3	Use the ICU day 3; telemetry is not sufficient but is preferable to no cardiac monitoring day 3	2	82 0	61 ICU 19 Telemetry
Patients hypoxic (i.e., p02 < 60) on day 3	Use supplemental oxygen therapy or intubate day 3	3	87	98
All patients hospitalized for CHF except those with systolic BP < 90 day 3	Use loop diuretic or digitalis day 3	94	91	92

[a] Any symptom or sign complex (ASSC) is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; chest pain, 1 point; confusion, 2 points; heart rate ≥ 130 beats per minute, 2 points; respiratory rate ≥ 30 per minute, 2 points; diastolic blood pressure ≥ 105 mm Hg, 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table 4.14

PROCESS CRITERIA FOR ACUTE MYOCARDIAL INFARCTION

		% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
If	Then		Pre-PPS	Post-PPS
All patients hospitalized for AMI	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:			
	Previous cardiac history	100	87	89
	Time of onset of AMI symptoms	100	95	96
	Social or family history	100	64	64
	Medication use immediately before admission	100	81	86
	Allergy history	100	56	62
	Alcohol use (or nonuse) or smoking habits	100	61	64
	Jugular veins examined	100	61	68
	Heart sounds examined	100	76	81
	Heart murmurs examined (or not present)	100	84	84
	Abdomen examined	100	97	97
	Lower extremity examined for edema	100	78	82
	Chest pain (presence or absence) day 1	100	94	94
	Chest pain (presence or absence) day 2	100	63	71
	Lung examination day 1	100	96	97
	Lung examination day 2	100	64	70
All patients hospitalized for AMI	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:			
	Chest pain (presence or absence) day 1	100	92	93
	Chest pain (presence or absence) day 2	100	92	92
	Premature ventricular contractions assessed day 1	100	63	67
	Premature ventricular contractions assessed day 2	100	71	75
	Weight day 1 or 2	100	58	65
	Cardiac monitor rhythm strips (at least 3 on day 1)	100	76	86
	Preadmission residence	100	92	94
All patients hospitalized for AMI	Within the initial two days of hospitalization, order each of the following:			
	Chest X-ray day 1 or 2	100	91	93
	Electrocardiogram day 1	100	94	97
	Electrocardiogram day 2	100	90	91
All patients hospitalized for AMI	Within the initial two days of hospitalization, order each of the following laboratory studies:			
	BUN	100	88	91
	Creatinine	100	66	79
	Venous bicarbonate	100	81	88
	Sodium	100	92	95
	Potassium	100	93	95
	White blood count	100	94	96
	Hematocrit or hemoglobin	100	95	96
All patients hospitalized for AMI	Order cardiac enzyme study day 1 (e.g., total CPK or lactate dehydrogenase (LDH) isoenzimes or CPK isoenzymes)	100	40	49 CPK or LDH isoenzymes
			46	45 Total CPK only
All patients hospitalized for AMI	Order cardiac enzyme study day 2 (e.g., total CPK or lactate dehydrogenase (LDH) isoenzymes or CPK isoenzyme)	100	51	56 CPK or LDH isoenzymes
			37	34 Total CPK only

Table 4.14—continued

		% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
If	Then		Pre-PPS	Post-PPS
Patients moderately or very sick (i.e., ASSC[a] ≥ 5) day 1 or 2	Obtain arterial blood gas day 1 or 2	34	67	74
Patients with cardiogenic shock with end organ damage, arrhythmias, *and* very sick (i.e., ASSC ≥ 7) day 1	Use ICU day 1; telemetry is not sufficient but is preferable to no cardiac monitoring	6	95 1	91 7
Patients with shock or very sick (i.e., ASSC ≥ 7) day 1	Use ICU day 1; telemetry is not sufficient but is preferable to no cardiac monitoring	16	88 8	89 ICU 7 Telemetry
Patients moderately sick (i.e., ASSC = 5–6) day 1	Use ICU day 1; telemetry is not sufficient but is preferable to no cardiac monitoring	8	83 9	82 ICU 15 Telemetry
Patients with congestive heart failure *and* somewhat sick (i.e., ASSC = 3–4) day 1	Use ICU day 1; telemetry is not sufficient but is preferable to no cardiac monitoring	8	80 10	80 ICU 14 Telemetry
Patients with congestive heart failure *and* not very sick (i.e., ASSC ≤ 2) day 1	Use ICU day 1; telemetry is not sufficient but is preferable to no cardiac monitoring	11	77 14	75 ICU 19 Telemetry
Patients somewhat sick (i.e., ASSC = 3–4) day 1	Use ICU day 1; telemetry is not sufficient but is preferable to no cardiac monitoring	14	77 11	75 ICU 22 Telemetry
Patients not very sick but some symptom or sign (i.e., ASSC = 2) day 1	Use ICU day 1 or use telemetry day 1; ICU is preferable	19	81 11	70 ICU 26 Telemetry
Patients with AMI and one or no symptoms or signs (i.e., ASSC = 0–1) day 1	Use ICU day 1 or use telemetry day 1; ICU is preferable	15	71 20	77 ICU 20 Telemetry
Patients with no evidence of AMI and one or no symptoms or signs (i.e., ASSC = 0-1) day 1	Use ICU day 1 or use telemetry day 1	3	55 23	71 ICU 29 Telemetry
Patients with cardiogenic shock with end organ damage, arrhythmias, *and* very sick (i.e., ASSC ≥ 7) day 2	Use ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring	4	95 1	91 ICU 7 Telemetry
Patients with shock or very sick (i.e., ASSC ≥ 7) day 2	Use ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring	13	92 5	87 ICU 10 Telemetry
Patients moderately sick (i.e., ASSC = 5–6) day 2	Use ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring	4	89 11	85 ICU 9 Telemetry
Patients with congestive heart failure *and* somewhat sick (i.e., ASSC = 3–4) day 2	Use ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring	3	80 12	93 ICU 5 Telemetry

Table 4.14—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
Patients with congestive heart failure *and* not very sick (i.e., ASSC ≤ 2) day 2	Use ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring	7	91 5	89 ICU 10 Telemetry
Patients somewhat sick (i.e., ASSC = 3–4) day 2	Use ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring	10	86 7	82 ICU 15 Telemetry
Patients at least somewhat sick (i.e., ASSC ≥ 3) on day 1 with or without shock and congestive heart failure *but* not very sick (i.e., ASSC ≤ 2) on day 2 with or without evidence of AMI	Use ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring	29	77 14	78 ICU 18 Telemetry
Patients not very sick (i.e., ASSC ≤ 2) on day 1 with or without evidence of AMI *and* not very sick but some symptom or sign (i.e., ASSC = 2) day 2	Use ICU day 2 or use telemetry day 2; ICU is preferable	4	88 4	78 ICU 22 Telemetry
Patients not very sick (i.e., ASSC ≤ 2) on day 1 *and* with AMI and one or no symptoms or signs (i.e., ASSC = 0–1) day 2	Use ICU day 2 or use telemetry day 2; ICU is preferable	22	76 17	75 ICU 24 Telemetry
Patients not very sick (i.e., ASSC ≤ 2) on day 1 *and* with no evidence of AMI and one or no symptoms or signs (i.e., ASSC = 0–1) day 2	Monitoring day 2 in ICU or telemetry is preferable to no monitoring	5	65 20	67 ICU 32 Telemetry
Patients with cardiogenic shock with end organ damage, arrhythmias, *and* very sick (i.e., ASSC ≥ 7) day 1 or 2	Place a Swan Ganz catheter on day 1 or 2	8	31	38
Patients with cardiogenic shock with end organ damage, arrhythmias, *and* very sick (i.e., ASSC ≥ 7) day 1	Use pressors or IV unloading agents day 1	6	71	76
Patients with cardiogenic shock with end organ damage, arrhythmias, *and* very sick (i.e., ASSC ≥ 7) day 2	Use pressors or IV unloading agents day 2	4	65	85

Table 4.14—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
Patients with ventricular tachycardia (VTach) day 1	Give antiarrhythmics day 1	1	100	88
Patients with PVCs day 1	Give antiarrhythmics day 1	23	69	69
Patients with VTach day 2	Give antiarrhythmics day 2	1	62	80
Patients with VTach day 2	Give antiarrhythmics day 2	17	62	65
Patients with 3rd degree heart block day 1 or 2 and anterior MI	Use pacemaker day 1 or 2	1	92	62
Patients with 3rd degree heart block day 1 or 2 and no anterior MI	Use pacemaker day 1 or 2	3	44	78
Patients given streptokinase	Document bleeding history (presence or absence)	2	0	14
Patients given streptokinase	Start streptokinase within 6 hours of the time symptoms were first noted	2	40	72
Patients with CHF but no hypotension day 1	Give loop diuretics day 1	19	51	54
Patients with CHF but no hypotension day 2	Give loop diuretics day 2	9	63	70
Patients with hypertension (diastolic BP ≥ 105) persisting for day 1 and 2	Give IV unloading agents, long-acting nitrates, oral or IV beta blockers, or calcium channel blockers day 2	3	56	88
Patients with chest pain and no IV unloading agents on day 2	Give short-acting nitrates day 2	36	54	54
Patients with chest pain day 1 and 2 and no evidence of hypotension or CHF on day 1 or 2 and no IV unloading agents on day 2	Give long-acting nitrates, oral or IV beta blockers, or calcium channel blockers on day 2	19	67	81
Patients with chest pain day 1 and 2 and evidence of hypotension or CHF on day 1 or 2 and no IV unloading agents on day 2	Give long-acting nitrates or calcium channel blockers on day 2	15	65	78
All patients hospitalized for AMI	On day 3 of the hospitalization, the physician should document each of the following in the medical record:			
	Chest pain (presence or absence)	100	60	70
	Lung examination	100	64	70
All patients hospitalized for AMI	On day 3 of the hospitalization, the nurse should document each of the following in the medical record:			
	Chest pain (presence or absence)	100	91	92
	PVCs assessed	100	69	71

Table 4.14—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Order chest X-ray on day 3	12	51	59
Patients with chest pain or somewhat, moderately, or very sick (i.e., ASSC ≥ 3) on day 3	Order electrocardiogram on day 3	45	81	78
Patients somewhat sick (i.e., ASSC = 3–4) on day 3	Order at least 1 of the following laboratory studies on day 3: BUN, creatinine, sodium, potassium	17	54	52
Patients moderately or studies very sick on day 3	Order at least 2 of the following laboratory on day 3: BUN, creatinine, sodium, potassium (i.e., ASSC ≥ 5)	12	52	71
Patients with chest pain day 3	Order cardiac enzyme study day 3 (e.g., creatinine phosphokinase (CPK) or lactate dehydrogenase (LDH) isoenzymes or total CPK)	19	38	32
Patients moderately or very sick (i.e., ASSC ≥ 5) day 3	Obtain arterial blood gas day 3	11	42	50
Patients very sick (i.e., ASSC ≥ 7) day 3	Use ICU day 3; telemetry is not sufficient but is preferable to no cardiac monitoring	5	94 4	94 ICU 3 Telemetry
Patients moderately sick but is (i.e., ASSC = 5–6) day 3	Use ICU day 3; telemetry is not sufficient preferable to no cardiac monitoring	7	90 10	89 ICU 8 Telemetry
Patients somewhat sick but is (i.e., ASSC = 3–4) day 3	Use ICU day 3; telemetry is not sufficient preferable to no cardiac monitoring	17	87 9	80 ICU 16 Telemetry
Patients at least somewhat but is sick (i.e., ASSC ≥ 3) on day 2 with or without shock and CHF *but* not very sick (i.e., ASSC ≤ 2) on day 3 with or without evidence of AMI	Use ICU day 3; telemetry is not sufficient preferable to no cardiac monitoring	19	84 9	85 ICU 13 Telemetry
Patients not very sick (i.e., ASSC ≤ 2) on day 2 *and* with AMI and not very sick (i.e., ASSC ≤ 2) day 3	Use ICU day 3 or use telemetry day 3; ICU is preferable	4	77 15	73 ICU 24 Telemetry
Patients not very sick (i.e., ASSC ≤ 2) on day 2 *and* with no evidence of AMI and not very sick (i.e., ASSC ≤ 2) on day 3	Monitoring day 3 in ICU or telemetry is not necessary	10	62 21	59 ICU 35 Telemetry
Patients with hypotension *and* moderately or very sick (i.e., ASSC ≥ 5) day 3	Use pressors or IV unloading agents day 3	9	52	61

Table 4.14—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
Patients with VTach day 1 or 2 or PVCs day 3	Give antiarrhythmics or oral or IVs blockers day 3	10	68	63
Patients with hypertension (diastolic BP ≥ 105) persisting for day 2 and 3	Give IV unloading agents, long-acting nitrates, oral or IV beta blockers, or calcium channel blockers day 3	1	78	88
Patients with chest pain and no IV unloading agents on day 3	Give short-acting nitrates day 3	26	59	47
Patients with chest pain day 2 and 3 and no evidence of hypotension or CHF on day 1 or 2 and no IV unloading agents on day 3	Give long-acting nitrates, oral or IV beta blockers, or calcium channel blockers on day 3	10	73	91
Patients with chest pain day 2 and 3 and evidence of hypotension or CHF on day 1 or 2 and no IV unloading agents on day 3	Give long-acting nitrates or calcium channel blockers on day 3	8	71	84

[a] Any symptom or sign complex (ASSC) is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; chest pain, 1 point; confusion, 2 points; heart rate ≥ 130, 2 points; respiratory rate ≥ 30 per minute, 2 points; diastolic blood pressure ≥ 105 mm Hg, 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table 4.15

PROCESS CRITERIA FOR PNEUMONIA

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
All patients hospitalized for PNE	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:			
	Sputum or cough (presence or absence)	100	79	77
	Previous pulmonary disease (presence or absence)	100	58	63
	Medication use immediately before admission	100	71	75
	Alcohol use (or nonuse)	100	40	44
	Tobacco use (or nonuse)	100	47	52
	Temperature	100	76	79
	Jugular veins examined	100	41	48
	Heart murmurs examined	100	76	76
	Lower extremity examined for edema	100	68	75
	Mental status assessed	100	61	65
	Lung examination day 1	100	98	98
	Lung examination day 2	100	59	68
	Shortness of breath (presence or absence) day 1	100	66	74
	Shortness of breath (presence or absence) day 2	100	25	31
All patients hospitalized for PNE	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:			
	Shortness of breath (presence or absence) day 1	100	67	78
	Shortness of breath (presence or absence) day 2	100	72	84
	Blood pressure assessment at least 3 times day 2	100	69	79
	Urinary continence (presence or absence)	100	66	76
	Ambulatory status	100	69	78
	Preadmission residence	100	96	98
Patients moderately or very sick (i.e., ASSC[a] ≥ 5) day 1 or 2	Within the initial two days of hospitalization, order:			
	Chest X-ray	31	99	100
	Electrocardiogram	31	77	75
All patients hospitalized for PNE	Within the initial two days of hospitalization, order each of the following laboratory studies:			
	BUN	100	83	90
	Creatinine	100	65	79
	Venous bicarbonate	100	77	84
	Sodium	100	86	93
	Potassium	100	87	93
	White blood count	100	99	98
	Hematocrit or hemoglobin	100	98	98
	White blood cell count differential	100	97	93
Patients moderately or very sick (i.e., ASSC ≥ 5) day 1 or 2	Order cardiac enzyme study day 1 or 2 (e.g., CPK)	31	35	34
Patients moderately or very sick (i.e., ASSC ≥ 5) day 1 or 2	Obtain arterial blood gas day 1 or 2	30	70	80

Table 4.15—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
Patients somewhat sick (i.e., ASSC = 3-4) day 1	Use the ICU day 1 or use telemetry day 1	29	7 4	9 ICU 10 Telemetry
Patients somewhat sick (i.e., ASSC = 3-4) day 2	Use the ICU day 2 or use telemetry day 2	17	19 5	17 ICU 11 Telemetry
Patients moderately sick (i.e., ASSC 5-6) day 1	Use the ICU day 1 or use telemetry day 1	18	19 7	18 ICU 13 Telemetry
Patients moderately sick (i.e., ASSC 5-6) day 2	Use the ICU day 2 or use telemetry day 2	8	31 4	35 ICU 12 Telemetry
Patients very sick (i.e., ASSC ≥ 7) day 1	Use the ICU day 1; telemetry is not sufficient but is preferable to no cardiac monitoring day 1	10	42 5	50 ICU 7 Telemetry
Patients very sick (i.e., ASSC ≥ 7) day 2	Use the ICU day 2; telemetry is not sufficient but is preferable to no cardiac monitoring day 2	4	52 11	53 ICU 17 Telemetry
Patients hypoxic (i.e., p02 < 60) on day 1	Use supplemental oxygen therapy or intubate day 1	27	83	90
Patients hypoxic (i.e., p02 < 60) on day 2	Use supplemental oxygen therapy or intubate day 2	8	94	93
Patients moderately or very sick (i.e., ASSC ≥ 5) day 1 and day 2 and arterial blood gases were not evaluated on either day	Use supplemental oxygen therapy or intubate day 1 or 2	1	77	64
All nonimmunocompromised with PNE	Use antibiotics within the first 4 hours	90	28	32
All immunocompromised patients hospitalized with PNE	Use antibiotics within the first 2 hours	10	3	4
Patients with fever (T > 101) on day 1 or 2	Order blood cultures day 1 or 2	42	56	68
Patients with fever (T > 101) on day 1 or 2	Order urine culture or urinalyses day 1 or 2	42	88	82
Patients with sputum for culture day 1 or 2	Document sputum gram stain quality day 1 or 2	53	59	68
All patients hospitalized for PNE	On hospital day 3, the physician should document each of the following in the medical record:			
	Shortness of breath (presence or absence)	100	21	27
	Lung examination	100	59	65

Table 4.15—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
All patients hospitalized for PNE	On hospital day 3, the nurse should document in the medical record:			
	Shortness of breath (presence or absence)	100	72	83
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Order a chest X-ray or an electrocardiogram on day 3	9	51	56
Patients somewhat sick (i.e., ASSC 3-4) on day 3	Order at least 1 of 4 venous blood studies on day 3 (e.g., creatinine, BUN, sodium, potassium)	13	43	42
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Order at least 2 of 4 venous blood tests (e.g., creatinine, BUN, sodium, potassium)	9	55	55
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Order a cardiac enzyme study (e.g., CPK) day 3	9	16	16
Patients moderately or very sick (i.e., ASSC ≥ 5) on day 3	Obtain an arterial blood gas day 3	9	48	59
Patients somewhat sick (i.e., ASSC 3-4) on day 3	Use the ICU day 3 or use telemetry day 3	13	22 7	16 ICU 11 Telemetry
Patients moderately sick (i.e., ASSC 5-6) on day 3	Use the ICU day 3 or use telemetry day 3	6	30 9	36 ICU 9 Telemetry
Patients very sick (i.e., ASSC ≥ 7) on day 3	Use the ICU day 3; telemetry is not sufficient but is preferable to no cardiac monitoring day 3	3	55 17	72 ICU 8 Telemetry
Patients hypoxic (i.e., p02 < 60) on day 3	Use supplemental oxygen therapy or intubate day 3	5	93	90

[a] Any symptom or sign complex (ASSC) is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; chest pain, 1 point; confusion, 2 points; heart rate ≥ 130 beats per minute, 2 points; respiratory rate ≥ 30 per minute, 2 points; diastolic blood pressure ≥ 105 mm Hg, 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table 4.16

PROCESS CRITERIA FOR CEREBROVASCULAR ACCIDENT

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
All patients hospitalized for CVA	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:			
	Previous cardiac history or hypertension	100	81	82
	Time of onset of neurologic symptoms	100	91	94
	Prior CVA/TIA	100	48	53
	Medication use immediately before admission	100	74	82
	Pupils assessed	100	80	82
	Gag reflex assessed	100	35	38
	Carotid bruits assessed	100	61	72
	Heart sounds assessed	100	57	63
	Muscle tone/strength assessed	100	82	86
	Limb reflexes assessed	100	64	71
	Mental status assessed	100	83	83
	Neurologic deficits (presence or absence) day 1	100	99	99
	Neurologic deficits (presence or absence) day 2	100	74	85
	Visit to patient day 1	100	100	100
	Visit to patient day 2	100	92	96
All patients hospitalized for CVA	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:			
	Nutritional intake assessed day 1	100	63	62
	Nutritional intake assessed day 2	100	88	90
	Pupils assessed day 1	100	43	62
	Pupils assessed day 2	100	38	57
	Blood pressure measured at least 3 times on day 2	100	79	86
All patients hospitalized for CVA	Within the initial two days of hospitalization, either the physician or the nurse should document each of the following in the medical record:			
	Urinary continence (presence or absence)	100	60	68
	Ambulatory status	100	73	80
	Preadmission residence	100	97	97
All patients hospitalized for CVA	Within the initial two days of hospitalization, order each of the following:			
	Chest X-ray	100	80	79
	Electrocardiogram	100	82	86
All patients hospitalized for CVA	Within the initial two days of hospitalization, order each of the following laboratory studies:			
	BUN	100	84	92
	Creatinine	100	62	79
	Venous bicarbonate	100	78	86
	Sodium	100	88	94
	Potassium	100	88	94
	White blood count	100	94	95
	Hematocrit or hemoglobin	100	94	95

Table 4.16—continued

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
Patients moderately, or very sick (i.e., ASSC[a] ≥ 2) day 1 or 2	Obtain arterial blood gas day 1 or 2	27	47	57
Patients moderately sick (i.e., ASSC = 2-3) day 1	Use ICU day 1	14	30	37
Patients very sick (i.e., ASSC ≥4) day 1	Use ICU day 1	6	54	58
Patients moderately sick (i.e., ASSC = 2-3) day 2	Use ICU day 2	12	35	39
Patients very sick (i.e., ASSC ≥ 4) day 2	Use ICU day 2	4	48	54
Posturing, no response to pain, or coma	Do CT scan, carotid angiography, brain scan, encephalogram, or lumbar puncture day 1 or 2	26	34	60c
All patients hospitalized for CVA	On day 3 of the hospitalization, the physician should document each of the following in the medical record:			
	Neurologic deficits (presence or absence)	100	68	78
	Lung examination	100	29	41
	Visit to patient	100	91	96
All patients hospitalized for CVA	On day 3 of the hospitalization, the nurse should document each of the following in the medical record:			
	Nutritional intake assessed	100	88	90
	Pupils assessed	100	31	49
Patients moderately sick (i.e., ASSC = 2-3) on day 3	Order at least 3 of the following laboratory studies on day 3: BUN, creatinine, sodium, potassium, white blood cell count, hematocrit or hemoglobin, venous bicarbonate	10	47	38
Patients very sick (i.e., ASSC ≥ 4) on day 3	Order at least 4 of the following laboratory studies on day 3: BUN, creatinine, sodium, potassium, white blood cell count, hematocrit or hemoglobin, venous bicarbonate	3	50	51
Patients moderately sick (i.e., ASSC = 2-3) day 3	Use ICU day 3	10	34	36
Patients very sick (i.e., ASSC ≥ 4) day 3	Use ICU day 3	3	58	56

[a] Any symptom or sign complex (ASSC) is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; heart rate ≥ 130 beats per minute, 2 points; respiratory rate ≥ 30 per minute, 2 points; diastolic blood pressure ≥ 105 mm Hg, 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table 4.17

PROCESS CRITERIA FOR HIP

If	Then	% of Patients to Whom Criteria Apply	% of Patients Meeting Process Criteria	
			Pre-PPS	Post-PPS
All patients hospitalized for HIP	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:			
	Past surgical history	100	75	77
	Medication use immediately before admission	100	98	98
	Prior living arrangements	100	70	73
	Alcohol use (or nonuse) or smoking habits	100	44	52
	Circumstances of hip injury	100	98	98
	Neck examined	100	90	90
	Heart examined	100	98	98
	Lungs examined	100	99	98
	Lower extremity examined for pulses	100	62	67
	Mental status assessed	100	68	70
All patients hospitalized for HIP	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:			
	Urinary continence (presence or absence)	100	62	69
	Ambulatory status	100	85	92
	Preadmission residence	100	97	98
All patients hospitalized for HIP	Within the initial two days of hospitalization, order:			
	Chest X-ray	100	92	93
	Electrocardiogram	100	90	93
All patients hospitalized for HIP	Within the initial two days of hospitalization, order each of the following laboratory studies:			
	BUN	100	85	87
	Creatinine	100	59	74
	Sodium	100	88	92
	Potassium	100	89	94
	White blood count	100	96	97
	Hematocrit or hemoglobin	100	96	97

Using our set of validated process criteria, we have an excellent starting point for continuing to understand the strengths and weaknesses of care provided to hospitalized Medicare patients in the United States. The data suggest that there is room for improvement in most aspects of care. The strong relationships between physician and nurse cognitive measures and mortality confirm the importance of clinicians as gatherers of data. We hope that physicians and nurses will use our results as encouragement to take the time necessary to gather and record essential data elements, and that the payment structure for clinicians will acknowledge that physicians' cognitive services have an important effect on outcomes. The findings of better outcomes for patients with better technical diagnostic and therapeutic processes encourage us that the technical advances of modern medicine do, in fact, also make a difference. Recognizing these important relationships, efforts should be made to identify the types of patients, physicians, and hospitals falling short in the performance of process. We should then identify reasons for the shortfalls and correct the problems. Our data demonstrate that lives are at stake.

The lack of a consistent process-outcome relationship for scales based on ICU and telemetry monitoring is disappointing. We believe that the problem lies in our imperfect measurement of the *if* in the if-then process statements. Ideally, we would like to demonstrate improved outcomes *if* monitoring with ICU and telemetry is appropriate and *if* the patient has a treatable disease. More work is needed to better understand how to identify the group of patients for whom use of the intensive care unit and telemetry makes a difference (Griner, 1973).

It is notable that we found a significant process-outcome relationship for patients with all four of the medical diseases studied, but not for hip fracture. This may be because short-term mortality occurs less often for hip fracture patients than for the other study diseases. Alternatively, it may be that mortality is not the best outcome to study for hip fracture patients. Another possibility is that the medical record does not provide an adequate data source for evaluating surgical, particularly intra-operative, processes. Methods for evaluating surgical processes of care need further development. Since the improvements in process noted after the introduction of prospective payment for hip fracture patients are consistent with improvements in care seen for the other four study diseases, we believe that care for hip fracture patients post-PPS has in fact improved.

In summary, our consistent findings across process scales and diseases suggest both that processes of care have improved from 1981 to 1986 and that there is still room for further improvement. This provides evidence that the implementation of PPS was not associated with a deterioration in care, even in areas that were most sensitive to the financial incentives provided by prospective payment to decrease the level of services, such as nursing activities and the use of intensive care units. This is an encouraging finding and indicates that the 24 percent decrease in length of stay post-PPS was not associated with deterioration in the process of inhospital care. It is our hope that our process criteria can be expanded and updated, both for our five diseases and for other diseases as well, to provide an ongoing system for monitoring how patients are treated as medical care evolves.

V. CHANGES IN QUALITY OF CARE BETWEEN 1981 AND 1986 FOR FIVE DISEASES AS MEASURED BY IMPLICIT REVIEW

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The changes in the reimbursement system for Medicare patients, described in previous sections, have given rise to national concern that the quality of medical care may have deteriorated. Physicians and patients feared that the process of medical care might be altered in favor of inappropriately low-cost treatment strategies. The state PROs were intended to provide a safeguard against these trends, but neither the public nor the medical profession was certain that PROs could accurately assess and influence the quality of medical care.

Quality of care can be judged either by implicit or explicit review of data from medical records (Brook, 1973; Altman et al., 1969; and Donabedian, 1982). Explicit review relies on preset criteria, whereas implicit review depends upon the practitioner's opinion to generate a quality rating. In Sec. IV we documented that the quality of medical care in the United States, when measured by explicit review of the medical record for five major diseases, has generally improved over the years between 1981 and 1986. Implicit review of the medical record, however, is the current community gold standard for making final judgments about the quality of medical care (Dans et al., 1985). It is the standard method used by hospitals, professional review organizations, and insurance companies to judge quality.

The purpose of this study was to improve implicit review, to determine the reliability and validity of the improved method, and then to use it to evaluate changes in the quality of medical care for Medicare patients in the United States between 1981 and 1986. We report as well upon the relationship between judgments of quality based on implicit review and those based on explicit review.

METHODS

Patient Sample

The patient sample for the explicit review portion of this study was described above.

All included medical records underwent explicit review. Ten percent of included charts (a total of 1,366 records) were selected to undergo implicit review. Stratified random sampling was used, with oversampling of deaths so that approximately 50 percent of patients whose records underwent implicit review were patients who had died in the hospital. This sampling plan maximized our chance of identifying patients for whom death occurred as a result of poor quality. In the analyses reported here, data have been reweighted to achieve representativeness of our findings for all the original 14,012 patients sampled.

Performing Implicit Review

Before undergoing implicit review, the inpatient records of all study patients were duplicated and deidentified by obliterating all names of patients, hospitals, physicians, nurses, cities, and states. Dates were retained.

To perform implicit reviews, reviewers were instructed to examine the entire medical record with the exception of nursing notes (Rubenstein et al., 1991). Nursing notes were available to the reviewer for use as needed, but because of time constraints were not reviewed in their entirety.

Twenty-five physician reviewers participated in the study. Each of the five state PROs participating in the study selected one reviewer per disease, but each reviewer reviewed records from all states. We randomly assigned records to reviewers. No reviewer reviewed patients from more than one of the five study diseases. All reviewers were board certified in appropriate specialties. Internists reviewed records of patients hospitalized with congestive heart failure, cardiologists reviewed acute myocardial infarction records, pulmonologists reviewed pneumonia records, neurologists reviewed cerebrovascular accident records, and orthopedists reviewed hip fracture records.

Implicit review, as performed in this study, required that reviewers be trained in the use of a structured review form with accompanying written guidelines. Reviews were budgeted at 30 minutes each; reviewers were instructed to keep to this time limit, although some reviews might require less time and some more. We budgeted training at 12 hours per physician. In training, we specifically avoided trying to change reviewers' opinions about what ideal or acceptable quality of care would look like; rather, our training addressed how different data sources within the medical record can be used to judge quality, how elements of the record that might be used to judge quality could be weighted, and what is meant by the terms excellent, medium, and poor care (Rubenstein et al., 1991; and Kahn et al., 1989).

Initial training of physician reviewers was carried out during one three-hour small-group session. Following the session, each physician reviewed two training records and participated in one one-half hour telephone call with study physicians. Physicians then reviewed three more records on their own at home; these records were discussed during a three-hour conference call involving all five physicians and two study investigators.

Reviewers were taught during training to anchor their ratings. For most items, reviewers were asked to use the lowest response category when the care given would have been highly likely to contribute to a bad outcome, whether or not a bad outcome actually occurred in that case. For rating the quality of a physician's history or clinical assessment, raters were instructed to use the lowest response category ("very poor") if the rater, when asked to see the patient at midnight, would have to start from scratch in his evaluation. A judgment of "adequate" meant that most essential historical and assessment observations were included, but additional data might be required for optimal diagnosis and treatment. "Excellent" meant that all necessary data were present. "Good" was somewhat better than adequate and "poor" somewhat worse.

Reviewers were asked to judge urban, rural, teaching, and nonteaching hospitals according to the same standard. They were asked not to adjust their ratings according to their guess about the type of hospital from which a record came. Reviewers were asked to rate care as inadequate (i.e., as "poor" or "very poor") when that care did not meet a level achievable by most hospitals, and not to judge care as inadequate solely for failure to perform extraordinary or controversial procedures.

Reviewers were asked to take account of DNR orders. They were asked to judge care for these patients according to their own implicit standards for the care of DNR patients. Reviewers were asked not to second-guess the medical records, in terms of the level of aggressiveness of treatment aspired to by the physicians caring for the patient, when no explicit statement about low aggressiveness of care was present in the record.

The Structured Implicit Review form, shown at the end of this section, included 27 items and asked the physician reviewers to rate specific aspects of the following: the process of physician and nursing care; the appropriateness of use of hospital services; patient prognosis; treatability of the patient's condition; preventability of death when it occurred; the quality of the outcome; and an overall assessment of the quality of care delivered during the hospitalization. Ratings were based on Likert scales; a five-point scale from very poor to excellent was used for most of the items. We used the same review form for patients with congestive heart failure, myocardial infarction, and pneumonia. We modified the form slightly for hip fracture and cerebrovascular accident.

To determine interrater reliability, a randomly selected sample of about 25 percent of all records were reviewed by two reviewers, and 3 percent were reviewed by all five reviewers.

Additional Data Sources

In addition to performing implicit reviews on the medical records, we used data from the previously described explicit reviews of these records (Sec. IV). To evaluate the actual outcomes of care of the patients whose care was assessed implicitly, we examined mortality rates 30 days after admission. We were able to find accurate postadmission mortality data from HCFA's Health Insurance Master file for 92 percent of our study sample (Sec. VII).

Statistical Methods

To facilitate analysis, we developed process scales and an overall quality of care scale. We used clinical judgment to group process items into scales. Process scales were created from the 19 items listed in questions 1–5 on the implicit review form. The overall quality of care scale was based on answers to questions 9 and 10. We used factor analysis to determine whether our process groupings made sense psychometrically; final scales were quite similar to our initial clinically developed scale groupings. We moved an item from one scale to another when a high correlation with the other factor indicated strongly that the item belonged in that grouping.

Overall Quality Scale. The overall quality of care scale consisted of two items: "Considering everything you know about the patient, please rate overall quality of care" with five response categories ranging from extreme, above standard, to extreme, below standard; and "Would you send your mother to these physicians in this hospital?" with four response categories ranging from definitely yes to definitely no. Responses to these questions were added together to form an eight-point overall quality of care scale from 2 (both questions answered with the highest possible rating of 1) to 9 (worst care). Cases reviewed by multiple reviewers were assigned the mean adjusted score across reviewers. We then divided the overall quality of care scale into four levels of care: (1) "very poor care," a score of 7.5 to 9; (2) "poor care," a score of 6.5–7.4; (3) "good care," a score of 3.5–6.4; and (4) "very good care," a score of 2–3.4. Poor care or very poor care means that responses to both of the overall quality questions were rated in the "below standard" or "probably would not send my mother" range.

Reliability. We hypothesized that some reviewers might judge care more harshly, and some more leniently, than others. We tested for the significance of this "reviewer effect" using a one-way analysis of variance. To perform this adjustment, we calculated the group of reviewers' mean score for a question or scale across patients, compared it to the individual reviewer's mean score for that question, and adjusted the individual reviewer's scores for all patients up or down proportionally to match the group mean. We then used the adjusted scores in our analyses.

We also used analysis of variance to assess interrater reliability because we use ordered scales. For example, a 5 on one of our scales is not very different from a 6, but very different from a 9; in assessing interrater reliability, analysis of variance takes these relative disagreements into account appropriately. Before calculating interrater reliability, we adjusted scores for reviewer effects as described above.

Components of Variance. We used components of variance analysis to understand reasons for disagreement among multiple reviewers of the same case, and to examine the relationship between this disagreement and the conclusions that could be drawn about the true quality differences between patients assigned particular quality ratings. The variance analysis of the distribution of cases between very good, good, poor, and very poor care included (1) the "reviewer effect" discussed above, (2) differences of opinion among reviewers, and (3) actual differences in the medical care delivered to the patient. We are clearly most interested in the last component of the variance. We used the variance-components model to adjust results of the overall quality scale for the reviewer effects and for differences of opinion among reviewers. These components are mathematically related to imperfect reliability. The figures generated by this method provide a conservative estimate of the amount of care judged to be inadequate.

Evaluating the Relationship Between Quality of Care and 30-Day Death. We used linear regression to evaluate whether poor quality of care measured implicitly by the overall quality scale predicted death within 30 days, after adjusting for patient sickness at admission (Sec. III). (Logistic regression produced similar results.)

We also used linear regression to determine whether reviewers assigned quality scores differently when patients died in, as compared to outside, the hospital. To account for the difference between earlier and later deaths, we controlled for the number of days between hospital admission and day of death in our analyses.

RESULTS

Patient Sample

A total of 278 records for congestive heart failure, 275 records for acute myocardial infarction, 273 records for pneumonia, 270 records for cerebrovascular accident, and 270 records for hip fracture were reviewed. This represented 93 percent of records randomly selected for implicit review. Of the 1,366 records reviewed, 993 were reviewed once, 333 were reviewed twice, 33 were reviewed five times, and seven (hip fracture) records were reviewed four times. To evaluate our sampling, we compared the implicit review sample to the explicit sample, which is known to be nationally representative (Sec. II). The implicit and explicit samples did not differ significantly in terms of age, sex, race, or type of hospital from which they came (Table 5.1).

Table 5.1

DEMOGRAPHIC CHARACTERISTICS OF PATIENTS IN IMPLICIT AND EXPLICIT REVIEW SAMPLES
(In percent)

	Review Sample	
Characteristics	Implicit (n=1,366)	Explicit (n=14,012)
Patient		
Age ≥ 80	43	41
Female	54	57
Non-white	16	19
Hospitals		
Rural	20	21
Any teaching	36	35
County	13	14
Serves high percentage Medicaid patients	16	19

Reliability

Process scales and the overall quality scale, with sample items and reliabilities, are listed in Table 5.2. Cronbach's alpha or interitem reliabilities were between 0.8 and 0.9. Interrater reliabilities for scales were mostly between 0.4 and 0.7, a range considered adequate for comparing groups of people (Koran, 1975). These reliabilities are in general better than those previously obtained by unstructured implicit review (Brook, 1973; Dubois et al., 1987; and Richardson, 1972). All scores are adjusted for the reviewer effect (discussed in Methods, above), which turned out to be small but significant, accounting for about 4 percent of the variance between cases.

Overall Quality Scale

The Pearson correlation coefficient between the two questions on the overall quality of care scale (see Table 5.2) was 0.86. The overall quality scale also closely correlated with the four process scales, and the preventable death item (Table 5.3). For example, the high correlation between the "physician assessment and plan" and the overall quality scale (r = 0.80) indicated that reviewers were much more positive in their assessments of the overall quality of care when the reviewers perceived that the patient was properly assessed by the physician early in the hospitalization. The correlation of the overall quality of care scale with nurse assessment, however, was low (r = 0.23), indicating that our overall quality score did not strongly reflect the reviewer's judgment of the initial nursing assessment. This was as expected, because we did not require review of all nursing notes. The correlation with patient prognosis was also low (r = 0.01), indicating that physicians were not confusing quality of care ratings with patient sickness at admission.

Overall, responses to the more detailed process items and scales accounted for about 72 percent of the variance in the overall quality scale. This finding indicated that the overall quality scale reflected reviewer's judgments about the multiple components of hospital care listed elsewhere on the review form and could appropriately be used as a summary measure.

Table 5.2

RELIABILITY OF IMPLICIT REVIEW SCALES AND ITEMS ACROSS FIVE DISEASES

Implicit Review Scales	Range of Number of Items in the Scale	Cronbach's Interitem Reliability		Interrater Reliability		Example Questions from Structured Implicit Review Form
		Mean	Range	Mean	Range	
Physician function and chronic disease:						
Physician's initial assessment of function, habit, and chronic disease	2–4	0.88	(0.82–0.92)	0.69	(0.65–0.74)	Rate physician documentation of prior and chronic disease from "excellent" to "very poor"
Physician assessment and plan:						
Physician's initial assessment of the acute disease	2–4	0.88	(0.67–0.94)	0.59	(0.25–0.69)	Rate completeness of initial physician data-gathering from "excellent" to "very poor"
Laboratory evaluation:						
Use of laboratory tests during the hospitalization	3–4	0.80	(0.74–0.88)	0.53	(0.22–0.74)	Rate use of venous blood tests, urinalyses, and sputum analyses from "definitely appropriate" to "definitely inappropriate"
Treatments:						
Initial treatment plan, orders, and use of medical therapies	3–6	0.82	(0.69–0.88)	0.49	(0.36–0.65)	Rate initial physician's treatment plan and orders from "excellent" to "very poor"
Overall quality:						
Overall quality of care during the hospitalization	2	0.92	(0.87–0.94)	0.54	(0.42–0.66)	Considering everything you know about this patient, please rate overall quality of care, from "extreme, above standard" to "extreme, below standard" and "definitely would send my mother to these physicians in this hospital" to "definitely would not"
Length of hospital stay (for patients who survived hospitalization)	1	NA[a]		0.30	(0.01–0.42)	"Definitely appropriate" to "definitely inappropriate"
Preventability of death (for patients who died)	1	NA		0.28	(0.04–0.50)	"Definitely preventable" to "definitely not preventable"
Quality of the outcome compared with that expected based on the patient's health status on day 1 of hospitalization	1	NA		0.60	(0.58–0.73)	"Much better than expected" to "much worse than expected"
Life expectancy based on the patient's presentation on day 1 of hospitalization[b]	1	NA		0.66	(0.58–0.73)	"< 1 month" to "> 1 year"
Treatability of the disease, assuming adequate to optimal care by the physician and the hospital[b]	1	NA		0.57	(0.34–0.69)	"Very effective" to "very ineffective"
Nurse assessment of prior and chronic disease, function, habits, psycho-social status[c]	1	NA		0.37	(0.20–0.50)	"Excellent" to "very poor"

[a] Interitem reliability is not applicable for single items.

[b] Item not present on review form for hip fracture.

[c] Item not present on review form for cerebrovascular accident.

Table 5.3

PEARSON CORRELATION COEFFICIENTS OF INDIVIDUAL IMPLICIT REVIEW SCALES AND ITEMS WITH THE OVERALL QUALITY OF CARE SCALE[a]

Implicit Review Scales and Items[b]	Mean for 5 Diseases	Range of Values Across 5 Diseases
Physician functional and chronic disease assessment	0.60	(0.43, 0.68)
Physician assessment and plan	0.80	(0.59, 0.85)
Laboratory evaluation	0.59	(0.40, 0.74)
Treatment	0.69	(0.49, 0.77)
Nurse assessment	0.23	(0.10, 0.36)
Quality of the outcome	0.36	(0.30, 0.41)
Length of stay	0.51	(0.39, 0.63)
Preventable death	−0.65	(−0.49, −0.66)
Patient prognosis at admission	0.01	(−0.01, 0.12)

[a] All scales and items except preventable death were scored so that a positive correlation indicates that better overall quality scores are associated with better performance on the scales in question; e.g., better assessments, better outcomes, or more appropriate length of stay.

[b] See Table 5.2 for definitions.

To further validate our structured implicit review, we examined the relationship between the process of care and mortality, after controlling for admission sickness. We found (Table 5.4) that, at each level (quartile) of sickness at admission, death within 30 days of hospital admission increased as quality of care measured by implicit review decreased. For instance, of patients in the third quartile of sickness, 13 percent who experienced good or very good process died, whereas 34 percent who experienced very poor process died. Aggregating across diseases and sickness quartiles, the relative risk of 30-day death for patients with very poor care as compared with all other patients is 2.08 ($p < 0.01$).

These findings were confirmed in multiple regressions in which our implicit quality of care measure significantly predicted outcome, even after adjusting for both implicit and explicit measures of sickness ($p < 0.01$).

These findings also held for cerebrovascular accident, but not for other diseases, when we examined by regression the relationship between the implicit quality of care measure and *out-of-hospital* death within 30 days, although the trends for all diseases for in- and out-of-hospital deaths were similar (i.e., patients with poor quality scores had an increased risk of death). The analysis of only out-of-hospital deaths eliminated the potential bias of reviewers rating the quality of care lower for patients who died inhospital. However, this analysis, which excluded patients with inhospital death, excluded about 82 percent of the deaths occurring within 30 days of admission. This greatly decreased the strength of the process-outcome relationship.

We found no significant effect of inhospital compared with out-of-hospital death on the overall quality score using linear regression. This indicates that reviewers were not systematically downrating care given to patients who died during their hospitalization rather than after it.

Table 5.4

PERCENTAGE OF PATIENTS WHO DIED WITHIN 30 DAYS OF HOSPITALIZATION, BY OVERALL QUALITY OF CARE RECEIVED AND LEVEL OF SICKNESS AT ADMISSION[a,b]

	Quartile				
Quality of Care by Implicit Review	I Least Sick (n=294)	II (n=301)	III (n=300)	IV Most Sick (n=302)	All (n=1,197)
Very good (n=189)	1	5	13	46	17
Good (n=675)	3	6	13	34	14
Poor (n=164)	2	4	8	49	13
Very poor (n=169) (2)	6*	17**	34**	55**	30**
Total patients (n=1,197)	3	7	15	41	17
Relative risk of 30-day death: very poor compared with all others[c]	2.43*	3.09**	2.79**	1.42**	2.08**

[a] Sickness at admission is measured explicitly in Sec. III. We constructed severity quartiles for all five diseases by dividing patients into four equal groups ranging from the least sick 25 percent to the most sick 25 percent.

[b] We found no evidence that reviewers systematically downrated quality for patients who died in the hospital. Stratifying by day of death inhospital deaths, and out-of-hospital deaths had equivalent quality scores. The sample size for out-of-hospital deaths was small, but the trend was the same as for inhospital deaths; i.e., patients with poor quality scores had an increased risk of death (p = 0.07).

[c] 30-day death rate for patients with very poor care differs from the corresponding rate for all other patients by an amount whose significance is indicated by asterisks: * = p < 0.05, ** = p < 0.01 (i.e., relative risks are significantly different from 1).

Comparison Between Implicit and Explicit Reviews

To compare implicit review and explicit review evaluations of quality of care, we used the four levels of care measured by our overall quality of care scale (see Methods, above). Explicit scales are scored from 0 to 100 based on the percentage of applicable explicit criteria adhered to in the patient's medical record. A higher score indicates better process by explicit criteria (Sec. IV).

Explicit process-scale scores were consistently lower (worse) for the group of patients who had received poor or very poor care as judged by implicit review. Results of comparisons with three of the explicit scales are presented in Table 5.5. "Physician Process Day 1 and Day 2" measures whether any physician recorded specified information about the history and physical examination on days 1 or 2 of the hospitalization. "Physician Process Day 3" asks whether any physician recorded such information on day 3 of the hospitalization. "Abnormal Lab Rechecked" asks whether highly abnormal laboratory results, such as a potassium < 3.0 mmol/L, were ever rechecked during the hospitalization.

For "Physician Process Day 1 and Day 2," and "Day 3," the very good and good care groups based on implicit review had significantly different explicit scores from each other ($p < 0.001$) and from the poor and very poor groups. For the "Abnormal Lab Rechecked" scale, good and very good could not be distinguished on the explicit scale from each other but scored significantly higher than did poor or very poor cases ($p < 0.01$). The poor and very poor groups, on the other hand, could not be distinguished from each other based on explicit

Table 5.5

COMPARISON BETWEEN IMPLICIT AND EXPLICIT PROCESS-SCALE SCORES FOR FIVE DISEASES
(Average process on explicit scales, 0–100)[a]

Overall Implicit Quality Scale	Physician Process Day 1, 2[b] (n=1,849)	Physician Process Day 3[c,d] (n=1,316)	Abnormal Lab Rechecked[e] (n=909)
Very good care	88	76	73
Good care	75	59	68
Poor care	69	48	57
Very poor care	63	47	55

[a] A higher score indicates better performance for explicit review scales.
[b] Significance of differences for all pairwise comparisons is $p < 0.001$.
[c] This scale was not measured for hip fracture.
[d] Significance of differences for all pairwise comparisons is $p < 0.001$ except for poor compared with very poor, which is not significant.
[e] Significant differences for very good compared with poor or very poor, and for good compared with very poor ($p < 0.01$).

process scores. These results held when patients discharged alive and those discharged dead were analyzed separately.

Overall, out of the 67 possible comparisons between explicit process scores and implicit review scores, 54 (81 percent) had higher scores for cases that were rated good or very good than poor or very poor, nine (13 percent) of the scales had equivalent scores for the two groups, and the remaining four (6 percent) had lower (worse) explicit process scores among the cases rated better on implicit review. This pattern of results is highly significant ($p < 0.001$).

Overall Level of Quality of Care and Pre-Post PPS Differences

Reviewers judged the quality of care for the majority of patients in our sample to be good (Table 5.6), combining all study years. Many more cases (82 percent, for all five diseases combined) were considered to be good or very good than were judged to be poor or very poor (18 percent). For congestive heart failure, however, 27 percent of the patients were

Table 5.6

QUALITY OF MEDICAL CARE FOR FIVE DISEASES AS MEASURED BY IMPLICIT REVIEW[a]

Disease	No. of Patients	Distribution of Patients on the Overall Quality of Care Scale, %				% Poor or Very Poor
		Very Good	Good	Poor	Very Poor	
Congestive heart failure	278	4	68	19	8	27
Acute myocardial infarction	275	10	69	15	7	23
Pneumonia	273	8	79	11	2	13
Cerebrovascular accident	270	12	64	15	9	24
Hip fracture	270	3	93	4	0	4
All diseases combined	1,366	7	75	13	5	18

[a] Reviewer effects removed (see the text).

judged to have received poor or very poor care; for cerebrovascular accident, 24 percent received poor or very poor care; for acute myocardial infarction, 23 percent received poor or very poor care; and for pneumonia, 13 percent received poor or very poor care. Patients with hip fracture were least often judged to receive poor or very poor care (4 percent).

For all diseases, reviewers judged the quality of care from the 1985–1986 time period more favorably than that in the 1981–1982 time period (Table 5.7). This difference was statistically significant for acute myocardial infarction and cerebrovascular accident ($p < 0.001$), and for congestive heart failure ($p < 0.01$). The trend was not significant for pneumonia ($p < 0.10$) or for hip fracture ($p < 0.20$). Virtually all scales and items on the form were rated higher in the post-PPS time period, 1985–1986, and most pre- post-PPS differences were significant at the $p < 0.001$ level when we aggregated our findings across the five diseases. Instability at discharge, however, was assessed by reviewers as significantly worse during 1985–1986 than during 1981–1982 (Table 5.8).

Physicians judged length of stay to be more appropriate overall in 1985–1986 than in 1981–1982 for three diseases (acute myocardial infarction, pneumonia, and cerebrovascular accident), and about equally appropriate for two diseases (congestive heart failure and hip fracture). The distribution of inappropriateness between stays that were inappropriately too long and inappropriately too short also changed from pre- to post-PPS, however, with fewer of the inappropriate stays during the 1985–1986 period being due to inappropriately long stays, and more being due to inappropriately short stays. This was particularly true of congestive heart failure, where 32 percent of patients were judged to have been discharged too soon during the later period compared with 24 percent in the earlier period, and for hip fracture, where 23 percent of patients were so judged in the later period, compared with 12 percent in the earlier period. For these two diseases, instability at discharge post-PPS was judged to be present in nearly half of the patients who were discharged too soon. Overall, the fraction of hospitalizations rated as both too short and as resulting in patients discharged unstable almost doubled from pre- to post-PPS (4.0 percent to 7.1 percent, $p < 0.05$).

Table 5.7

PERCENTAGE OF PATIENTS WITH POOR OR VERY POOR CARE PRE- AND POST-PPS[a]

Disease	No. of patients (Pre- and Post-PPS Combined)	Pre-PPS (n=669)	Post-PPS (n=697)	Difference (Post–Pre)[b]
Congestive heart failure	278	35	22	-13*
Acute myocardial infarction	275	33	13	-20**
Pneumonia	273	17	10	-7+
Cerebrovascular accident	270	36	16	-20**
Hip fracture	270	5	2	-3
Five diseases combined	1,366	25	12	-13**

[a] Reviewer effects removed.

[b] Significance of pre- post-PPS difference is indicated by the following symbols: + = $p < 0.10$, * = $p < 0.01$, ** = $p < 0.001$. The pattern of significance takes into account not only the size of the pre- post-PPS difference but also reliability.

Table 5.8

CHANGES IN THE PERCENTAGE OF PATIENTS JUDGED TO HAVE INAPPROPRIATE LENGTH OF STAY FOR FIVE DISEASES PRE- AND POST-PPS[a]

	Probably or Definitely Inappropriate Length of Stay		Too Long		Too Short		Too Short and Unstable at Discharge[b]	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Congestive heart failure (n=247)	34	35	10	3*	24	32	12.5	17.3
Acute myocardial infarction (n=212)	30	11*	16	3*	14	8	2.1	0.0
Pneumonia (n=235)	16	12	10	5*	6	7	0.6	5.1*
Cerebrovascular accident (n=216)	42	25*	32	17*	10	8	0.6	1.6
Hip fracture (n=258)	27	28	15	5*	12	23*	3.6	9.4
Five diseases combined (n=1,168)	30	23*	17	7*	13	17	4.0	7.1*

NOTE: * $p < 0.05$ for pre- post-PPS comparison.

[a] Includes only patients discharged alive.

[b] The percentages represent the proportion of all patients with the disease (e.g., n=247 for heart failure) who were judged both to be unstable and to have had a too-short stay.

DISCUSSION

Over the past 20 years, implicit review of the medical record by physicians has been the community gold standard for judging medical care (Dans et al., 1985). Research has demonstrated that this approach to quality of care assessment has value (Dubois et al., 1987; Richardson, 1972; Morehead et al., 1971; Payne, 1967; Peters, 1972; Sheps, 1955; and Fine et al., 1971), but few studies have rigorously measured the performance of the implicit review technique (Brook, 1973; Dubois et al., 1987; and Richardson, 1972). We have retooled this classical method for performing quality review and have found that, in terms of reliability, our structured approach to implicit review performs as well as many other clinical measurements that physicians perform, such as determining the presence or absence of the dorsalis pedis pulse (39 percent agreement) or determining whether an electrocardiogram is abnormal (84 percent agreement) (Koran, 1975). We have also demonstrated a process-outcome link with implicit review (e.g., higher scores on implicit review lead to better outcomes). We obtained our reliabilities and process-outcome link in a nationally representative, and therefore diverse, sample of physicians and patients (Wennberg and Gittelsohn, 1973; and Sec. II). Reliabilities were sufficiently high to allow meaningful comparisons between groups of patients, although a single review may not be reliable enough to accurately judge whether an individual patient received poor care.

We compared implicit and explicit review to determine whether these two methods measured the same quality of care constructs, or whether they measured entirely different aspects of the quality of medical care. Happily, the two methods appear to measure similar concepts.

When we used implicit review to judge the quality of medical care delivered to a nationally representative sample of patients with the five diseases we selected for study, we found that although most care is judged to be good or very good, a significant proportion of care was judged to be poor or very poor. Associated with the institution of prospective payment and implicit review of medical records by PROs, the proportion of care rated poor or very poor decreased between 1981–1982 and 1985–1986 from about one-quarter of patients to about one-eighth of patients. A similar result is reported in Sec. IV when explicit review is used.

Many fewer patients were judged to have been kept in the hospital too long during the later time period. Of concern, however, is the increasing number of patients judged to have been discharged too soon and, in particular, with significant instability at discharge. A similar increase in patients discharged unstable is reported in Sec. VI, using explicit review criteria.

In summary, structured implicit review performed well as a method for measuring the quality of medical care delivered to Medicare patients. This is good news for PROs, who perform the bulk of quality reviews nationally and use implicit review to do so. The study's optimistic result that the quality of medical care has improved post-PPS should serve as encouraging news that hospitals, physicians, and other health professionals continue to put patient needs first. However, substantial improvement is still possible, and the increasing rate of unstable discharges found by both implicit and explicit review is of concern.

Card 001 *1-3/*

DRG/QC STUDY
IMPLICIT REVIEW FORM
(For Congestive Heart Failure, Acute Myocardial Infarction and Pneumonia)

Case ID: ☐☐☐☐☐

Review Date ☐☐ ☐☐ ☐☐ *4-8/* *9-14/*
Month Day Year

1) Please rate the quality of physician and nurse documentation of each of the following: patient's prior and chronic disease, functional status, habits, and psychosocial status prior to the current acute illness.

	excellent (1)	good (2)	adequate (3)	poor (4)	very poor (5)	
a) physician documentation of prior and chronic disease	___	___	___	___	___	*15/*
b) physician documentation of functional status (e.g., ambulation)	___	___	___	___	___	*16/*
c) physician documentation of habits (e.g., alcohol, smoking, diet)	___	___	___	___	___	*17/*
d) physician documentation of psychosocial status (e.g., dementia, depression, nursing home residence)	___	___	___	___	___	*18/*
e) nurse documentation of prior and chronic disease, functional status, habits, and psychosocial status	___	___	___	___	___	*19/*

f) Check here if the record demonstrates evidence that the physician has ready access to additional records that supplement the current data regarding the patient's prior condition. ☐ *20/*

2) Please rate the physician initial assessment of acute medical problems present at admission. Base your answer on the history, physical, and labs.

	excellent (1)	good (2)	adequate (3)	poor (4)	very poor (5)	
a) completeness of initial data gathering	___	___	___	___	___	*21/*
b) integration of admission information and development of appropriate diagnoses	___	___	___	___	___	*22/*
c) initial treatment plan and initial orders	___	___	___	___	___	*23/*

3) Assume adequate to optimal care and assume the patient recovers from this episode of acute myocardial infarction. What do you believe is this patient's life expectancy?

< 1 month ____ (1) *24/*
1-6 months ____ (2)
> 6 months-1 year ____ (3)
> 1 year ____ (4)

4) Assume adequate to optimal care by the physician and hospital. How effective is medical science in treating this patient's acute illness or in preventing worsened health status due to the illness? Consider the severity of the patient's acute illness and the patient's chronic reserve.

very effective ____ (1) *25/*
effective ____ (2)
not so effective ____ (3)
very ineffective ____ (4)

5) Considering the entire hospitalization, on average, was use of these services appropriate with respect to the patient's needs? If not appropriate, was it because of underuse?

	definitely yes (1)	probably yes (2)	probably no (3)	definitely no (4)	under-use		
a) monitoring intensity	____	____	____	____		a)	*26/*
ai) intensive care	- - - - - -	- - - - - -	- - - - - -	- - - - - -	☐	ai)	*27/*
aii) telemetry without intensive care	- - - - - -	- - - - - -	- - - - - -	- - - - - -	☐	aii)	*28/*
b) respiratory therapy delivered	____	____	____	____	☐	b)	*29-30/*
c) O_2 and ventilation	____	____	____	____	☐	c)	*31-32/*
d) arterial blood gases	____	____	____	____	☐	d)	*33-34/*
e) physical therapy delivered	____	____	____	____	☐	e)	*35-36/*
f) EKGs	____	____	____	____	☐	f)	*37-38/*
g) chest x-rays	____	____	____	____	☐	g)	*39-40/*
h) venous blood tests, urinalyses, sputum analyses	____	____	____	____	☐	h)	*41-42/*
i) consultations	____	____	____	____	☐	i)	*43-44/*
j) medications (type and route)	____	____	____	____	☐	j)	*45-46/*

ANSWER QUESTION 6 ONLY IF THE PATIENT WAS DISCHARGED ALIVE

6) Was length of stay appropriate given the patient's status at discharge and disposition plans?

definitely yes ____ (1) *47/*
probably yes ____ (2)
probably no ____ (3)
definitely no ____ (4)

6a) If probably or definitely not appropriate, how would you describe length of stay?

too short ____ (1) *48/*
too long ____ (2)

6b) If length of stay was too short or too long, what were the apparent reasons? Check one or more reasons if applicable.

Too short		Too long		
i) Patient too unstable	☐	v) Waiting for nursing home or ECF bed	☐	*49-50/*
ii) Work-up incomplete	☐	vi) Waiting for home care support service	☐	*51-52/*
iii) Rehabilitation incomplete	☐	vii) Patient or family refused discharge	☐	*53-54/*
iv) Patient or family insisted on discharge	☐	viii) Waiting for procedure	☐	*55-56/*

ANSWER QUESTION 7 ONLY IF THE PATIENT DIED DURING THE HOSPITALIZATION

7) Was the patient's death preventable?

definitely preventable ____ (1) *57/*
probably preventable ____ (2)
probably not preventable ____ (3)
definitely not preventable ____ (4)

ANSWER THE REMAINING QUESTIONS FOR ALL PATIENTS

8) How would you characterize the patient's outcome at discharge?

much better than expected	____ (1)	58/
better than expected	____ (2)	
as expected	____ (3)	
worse than expected	____ (4)	
much worse than expected	____ (5)	

9) Considering everything you know about this patient, please rate overall quality of care.

extreme, above standard	____ (1)	59/
above standard	____ (2)	
adequate	____ (3)	
below standard	____ (4)	
extreme, below standard	____ (5)	

10) Would you send your mother to these physicians in this hospital?

definitely yes	____ (1)	60/
probably yes	____ (2)	
probably no	____ (3)	
definitely no	____ (4)	

VI. PPS AND IMPAIRMENT AT DISCHARGE: THE QUICKER-AND-SICKER STORY REVISITED

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Since the introduction in 1983 of PPS, there has been considerable anecdotal evidence that patients are leaving the hospital "quicker and sicker" (Coulton, 1988; Coe et al., 1986; and Neu and Harrison, 1988). However, there has been a dearth of systematic evidence to support the assertion that post-PPS patients are discharged sicker. The evidence that has been available emanates largely from Congressional testimony about individual cases or from nonsystematic surveys of patients or physicians.

We do know that PPS has been associated with dramatic decreases in length of stay. For instance, between 1981 and 1986, length of stay fell 21 percent for congestive heart failure (2.3 days), 18 percent for acute myocardial infarction (2.3 days), 14 percent for pneumonia (1.7 days), 28 percent for hip fracture (5.6 days), and 32 percent for cerebrovascular accident (5.1 days) (Sec. VII). Although this trend for decreases in length of stay has stabilized, it has not reversed (Witsberger and Kominsky, 1990). This decrease in length of stay, if associated with increased illness or impairment at hospital discharge, might adversely affect a patient's recovery.

This section provides nationally representative data about the level of impairment at discharge before and after the implementation of PPS. To answer correctly the question of whether patients are inappropriately discharged sicker since the implementation of PPS, we must first define a valid measure of impairment at discharge and then determine if patients discharged from the hospital sicker do worse than expected. If patients who are discharged clinically impaired die more frequently than expected, then allowing an increase in the number of patients discharged with an instability would appear to be unwise. On the other hand, if such patients are discharged for recovery to nursing homes or to care-givers at home who can handle an increased level of impairment without a concomitant increase in deaths, then "earlier" and "sicker" discharges would not be an inappropriate outcome.

METHODS

The study methods, including design, sampling, and analysis strategy, were described in Sec. II.

This section, because it concerns patients discharged alive from the hospital, excludes patients who died in the hospital, who were directly transferred to other acute care hospitals, or who had a DNR order written some time during the hospitalization. These exclusions reduced the maximum sample size from 14,012 to 10,913. The sample does include patients who were admitted to the hospital from a nursing home. The results reported here are not qualitatively affected by excluding patients who were in a nursing home before hospitalization. (See App. E.)

CONSTRUCTION OF MEASURES FOR DISCHARGE IMPAIRMENT

Using clinical judgment, we constructed three measures of discharge impairment (see Table 6.1): instability at discharge, sickness at discharge, and abnormal last laboratory values. Data used to construct the first two measures came primarily from the day of discharge or day before discharge. Since most patients are discharged in the morning, this means that the abnormality was almost always noted in the last 24 hours of hospital admission.

Instability variables are designed to identify patient problems present at discharge (1) that clinicians generally agree should be corrected before discharge and (2) that are likely to cause poor outcomes if not corrected. In general, instability variables reflect clinical problems that first occurred before discharge and that were not present at admission. Sickness variables are designed to measure sickness at discharge regardless of whether the problem should or could have been corrected at discharge. The key distinction between our definitions of instability and sickness rests with the "correctability" of the conditions. For example, the sickness variables include patients who have chest pain on the day before the day of discharge even though they may have had chest pain daily for weeks. The instability variables, on the other hand, include a subset of the patients with sickness at discharge. In this case, only those who have chest pain at discharge but not at admission are included. As seen in Table 6.1, 8.3 percent of the AMI patients had sickness at discharge caused by the presence of chest pain on at least one of the last two days of hospitalization, but 0.3 percent of AMI patients had instability at discharge caused by the presence of chest pain that was not present at admission.

Abnormal last laboratory values reflect the presence of abnormal findings the last time a test was performed during the hospitalization, regardless of when the value was obtained. The three measures of impairment (instability at discharge, sickness at discharge, and abnormal last laboratory values) consisted of a maximum of 10, 11, and 8 items, respectively.

ANALYSIS

Virtually all the analyses reported in this section are based on cross-tabulations and chi-square tests of significance. However, we did use multivariate techniques (linear and logistic regression) to adjust for differences in patient sickness at the time of hospital admission when studying discharge impairment before and after prospective payment (Sec. III). The results from this analysis are qualitatively consistent with the simpler unadjusted analyses reported here (App. E). In addition, emphasis is given in this section to the instability at discharge measure because it is clinically the most appealing of our three discharge measures. It consists of symptoms and signs, almost all newly present at discharge, that we believe are more likely to be correctable or in need of urgent attention than impairments that have been present throughout the course of the hospitalization. A patient with heart failure who is discharged from the hospital a little short of breath when he previously was severely short of breath probably represents a different and less remediable situation than a patient who is discharged short of breath without having had that symptom during the earlier part of the hospitalization. In addition, because the abnormal last laboratory measure potentially used data that were obtained before the immediate discharge period, it was felt to be less precise as a clinical measure of impairment at discharge.

Table 6.1

PERCENTAGE OF PATIENTS DISCHARGED WITH IMPAIRMENT, BY MEASURES OF IMPAIRMENT

Measures	CHF (n=2,348)	AMI (n=1,946)	PNE (n=2,141)	CVA (n=1,927)	HIP (n=2,551)	5 Diseases (n=10,913)
Instability at Discharge[a]						
Fever (temperature > 101°F)	0.0	0.2	0.2	0.3	0.2	0.2
New incontinence	4.6	—	5.8	15.6	12.3	9.5
New chest pain	1.4	0.3	1.3	—	2.8	1.5
New shortness of breath	1.5	1.1	1.5	1.5	(b)	1.4
New confusion	4.5	2.8	2.5	—	5.5	3.9
New heart rate ≥ 130	0.7	0.2	0.5	0.4	0.2	0.4
New respiratory rate ≥ 30	1.9	0.7	1.8	1.8	1.5	1.6
Diastolic BP ≥ 105	1.5	0.5	1.1	2.9	0.6	1.3
New systolic BP < 90	2.1	1.6	1.2	1.4	0.7	1.4
New low heart rate < 50	—	1.8	—	—	—	—
New premature ventricular contractions	—	0.9	—	—	—	—
≥ 1 instability	15.4	9.5	14.3	21.3	21.0	16.5
Mean no. instabilities	0.18	0.10	0.16	0.24	0.24	0.18
Mean no. instabilities among patients with ≥ 1 instability	1.2	1.1	1.1	1.1	1.1	1.1
Sickness at Discharge[a]						
Fever (temperature < 101°F)	0.0	0.2	0.2	0.3	0.2	0.2
New incontinence	4.6	—	5.8	15.6	12.3	9.5
Chest pain	5.5	8.3	4.8	—	3.3	5.3
Shortness of breath	29.5	7.8	15.8	3.7	(b)	15.0
Confusion	13.2	7.6	11.1	—	10.4	10.7
Heart rate ≥ 130	1.2	0.4	0.8	0.4	0.2	0.6
Respiratory rate ≥ 30	5.5	1.3	8.5	3.3	2.4	4.2
Diastolic BP ≥ 105	1.5	0.5	1.1	2.9	0.6	1.3
Systolic BP < 90	4.4	3.6	1.9	1.6	0.9	2.4
New decubitus	1.2	—	2.1	2.4	8.6	3.8
Low heart rate < 50	—	4.1	—	—	—	—
Premature ventricular contraction	—	2.3	—	—	—	—
Parenteral antibiotics	—	—	36.1	—	—	—
≥ 1 sickness	47.6	29.4	60.4	25.2	30.8	39.0
Mean no. sicknesses	0.67	0.36	0.88	0.30	0.39	0.52
Mean no. sicknesses among patients with ≥ 1 sickness	1.4	1.2	1.5	1.2	1.3	1.3
Abnormal Last Laboratory Values[c]						
Potassium[d]	6.3	3.8	7.8	7.1	6.7	6.3
Sodium[e]	2.6	2.2	2.9	1.8	2.8	2.5
Renal distress[f]	4.1	2.4	2.6	1.9	1.6	2.5
Hematocrit (low)[g]	2.8	—	0.5	2.1	3.9	2.3
WBC (high)[h]	9.3	—	12.7	11.0	13.8	11.7
Weight increase > 3 lb	2.9	2.2	—	—	—	2.6
CHF by X-ray worsening	4.3	0.9	7.0	—	4.2	4.1
> 1 laboratory abnormality	27.6	10.7	29.2	20.9	29.1	24.1
Mean no. abnormalities	0.32	0.11	0.33	0.24	0.33	0.27
Mean no. abnormalities among patients with ≥ 1 abnormality	1.16	1.05	1.14	1.14	1.13	1.13

[a] All measures of discharge instability and sickness evaluate the presence of symptoms or signs on the day before discharge or the day of discharge.

[b] For hip fracture, chest pain is defined as chest pain or shortness of breath. Other entries marked with a dash (—) indicate that this variable was not included in the definition of impairment for a particular procedure. For example, new incontinence is not included in instability or sickness for AMI.

[c] Each reported value is the last inhospital value. When comparisons are made, the last value is compared with the most recent prior inhospital value. If only one value is available during the hospital stay, that value is counted as the last laboratory value even if it was also the first.

[d] Abnormal potassium (meq/l) is defined as a value ≤ 2.9, a value ≥ 6.0, or a value between 5.5 and 5.9 but rising or 3.0–3.4 and falling.

[e] Abnormal sodium (meq/l) is defined as a value < 119, a value ≥ 155, or a value between 120 and 129 but falling, or between 150 and 154 but rising.

[f] Renal distress (mg/dl) is defined as a creatinine value > 6.0, a rise in creatinine > 0.5, a BUN value > 100, or a BUN rise ≥ 25.

[g] Low hematocrit (%) is defined as < 24.9 or between 25-34.9 with a drop ≥ 7.0 (the drop was not measured for pneumonia).

[h] High white blood cell count (cells x 1,000/cu mm) is defined as ≥ 12 and rising (the rise was not measured for pneumonia).

RESULTS

Considering all years of the study, both pre- and post-PPS, about one out of six patients (17 percent) were discharged with at least one instability, two out of five patients (39 percent) were discharged with at least one measure of sickness, and about one out of four (24 percent) had an abnormal last laboratory value (see Table 6.1). (See App. E.) The presence of one or more instabilities at discharge varied across diseases by a factor of two, with about one in ten patients who had a myocardial infarction being discharged with one or more instabilities, compared to one in five patients with cerebrovascular accident or hip fracture. Among those with one or more measures of instability, most had just one impairment, with a mean number of instabilities for those who had one or more instabilities varying by disease from 1.1 to 1.2. Thus, almost all information about this measure can be captured by a dichotomous variable, zero instabilities at discharge compared with one or more.

The development of new incontinence of urine contributed most to labeling a person as unstable at discharge for the four diseases for which it was measured (i.e., excluding acute myocardial infarction). For patients with acute myocardial infarction, the most predominant impairment was new confusion. Confusion was also an important contributor to instability for patients with the other four conditions as well.

The degree of sickness at discharge varied among diseases from about one in four patients discharged with an impairment who were admitted with a myocardial infarction (29 percent), cerebrovascular accident (25 percent), or hip fracture (31 percent), to three out of five patients admitted with pneumonia (60 percent). Like the instability measure, most people with one or more measures of sickness had only one, with a range by disease from 1.2 to 1.5. New incontinence contributed most to the sickness measure for patients with a cerebrovascular accident and hip fracture, whereas for heart failure and pneumonia it was shortness of breath, and for myocardial infarction it was chest pain. Other important contributors were confusion for heart failure, shortness of breath and confusion for acute myocardial infarction, confusion and increased respiratory rate for pneumonia, and confusion and new decubitus for hip fracture patients.

The presence of one or more abnormal last laboratory values varied from a low of one in ten patients discharged with a myocardial infarction to about one in three patients discharged with pneumonia or hip fracture. For the four diseases in which it was measured (i.e., excluding myocardial infarction), the leading cause of abnormal last laboratory studies was a high white blood cell count (>12,000 cells/cu mm and rising in relation to the prior study). An abnormal last potassium value (<2.9, >6.0, 5.5–5.9 and rising, or 3.0–3.4 and falling in relation to the prior study—measured in meq/l) was the leading abnormality for acute myocardial infarction patients and the second leading abnormality at discharge for patients with the other four diseases. About one out of every 16 patients (6 percent) across all five diseases was discharged with an abnormal potassium result.

Using regression techniques, we determined the relationship between the instability at discharge measure and our measures of overall inhospital process of care and sickness at the time of hospital admission. Both measures are disease-specific and strongly predict inhospital and posthospital death (Secs. II–IV). In general, instability was not explained by these measures (App. E). Only for congestive heart failure was severity at admission related to instability at discharge ($p = 0.04$). All process relationships with instability were insignificant except for congestive heart failure ($p = 0.02$), and this relationship was in the "wrong" direction (i.e., better process predicted more instability). Further, the amount of variance explained in these disease-specific regressions varied from only 0.5 percent for congestive heart failure to 2.5 percent for hip fracture patients. Thus, instability at discharge is not an alternative measure of inhospital process, and people within a disease category who are sicker at admission are not more likely to be discharged unstable relative to those who are less sick at admission.

Patients with instability were more likely to be discharged to an institution (Table 6.2). In addition, discharge to an institution was associated with a significantly higher likelihood of discharge impairment according to all three of our measures (Table 6.3). On average, about 22 percent of patients discharged to an institution had one or more instabilities, whereas 13 percent of those going home are so classified (relative risk, 1.8). The relative risk is largest for hip fracture (relative risk, 2.0) and least for myocardial infarction (relative risk, 1.1). Sickness at discharge is the most common impairment. Fifty percent of patients discharged to an institution had one or more measures of sickness, whereas 34 percent of those discharged to home were so affected (relative risk, 1.5). For abnormal last laboratory values, 32 percent were discharged to an institution with an abnormality compared to 25 percent discharged to home (relative risk, 1.3).

Table 6.2

PERCENTAGE OF PATIENTS DISCHARGED TO AN INSTITUTION, BY IMPAIRMENT AT DISCHARGE[a]

Measures of Impairment	One or More Impairments?	CHF	AMI	PNE	CVA	HIP	5 Diseases
Instability at discharge	No	12.9	7.3	22.1	35.5	56.6	28.5
	Yes	20.5 **	8.4	35.9 **	61.7 **	76.0 **	41.7 **
Sickness at discharge	No	11.4	5.7	19.5	34.1	54.1	25.4
	Yes	17.1 **	11.4 **	27.1 **	61.8 **	75.5 **	39.0 **
Abnormal laboratory	No	9.8	6.7	22.7	38.5	58.8	27.6
	Yes	25.5 **	13.0 **	27.5 *	51.1 **	65.3 *	40.5 **

[a] * $p < 0.05$, ** $p < 0.01$, based on chi-square test of discharge destination of patients with one or more impairments compared with those having no impairments.

Table 6.3

PERCENTAGE OF PATIENTS DISCHARGED TO HOME OR INSTITUTIONALIZED WITH ONE OR MORE MEASURES OF IMPAIRMENT AT DISCHARGE

Measures of Impairment	Discharge Destination	CHF	AMI	PNE	CVA	HIP	5 Diseases
Instability at discharge	Home	14.1 **	9.4	12.0 **	14.2 **	12.8 **	12.5 **
	Institution	22.4	10.8	21.3	32.0	26.3	22.4
Sickness at discharge							
	Home	46.2 **	28.2 **	58.0 **	16.8 **	19.3 **	33.7 **
	Institution	57.8	45.3	68.0	37.9	38.3	49.5
Abnormal laboratory	Home	43.5 *	10.0 **	27.9 *	17.7 **	25.8 *	25.0 **
	Institution	49.9	18.7	33.3	26.0	31.3	31.8
Sample size	Home	1,966	1,736	1,596	1,121	998	7,417
	Institution	322	139	507	782	1,543	3,293

NOTE: * $p < 0.05$, ** $p < 0.01$; chi-square test of level of impairment of patients discharged home compared with those discharged to an institution.

Tables 6.4 through 6.9 show detailed data for various time intervals and destinations. Tables 6.4, 6.5, 6.8, and 6.9 include patients regardless of discharge destination and Tables 6.6 and 6.7 include only those patients with a discharge destination of home. Tables 6.4 through 6.7 present mortality rates 30 and 90 days posthospital discharge, and Tables 6.8 and 6.9 present mortality rates 30 and 90 days posthospital admission. Each table confirms the previous findings and shows higher death rates for patients discharged with instability. For example, Table 6.4 shows a 30-day postdischarge mortality rate of 7.9 for patients discharged with instability as compared with 4.0 for patients discharged without instability ($p < 0.05$). This finding is significant for each of the study diseases except acute myocardial infarction. Table 6.6 shows 30-day postadmission mortality rates for patients discharged to home. For the five diseases combined, the mortality rate is 5.5 for patients discharged with at least one instability and 2.5 for patients discharged without instability ($p < 0.05$).

The risk of death at 90 days following discharge is 16 percent for patients discharged unstable and 10 percent if instability was not present at discharge (relative risk, 1.6). The highest condition- specific relative risk of death within 90 days postdischarge was for hip fracture patients (2.0) and lowest for myocardial infarction patients (1.1).

Each table (Tables 6.4 through 6.9) presents the instability-death relationship for all patients (i.e., pre- and post-PPS samples combined), for the pre-PPS period sample alone, and for the post-PPS period sample alone. The data show that the strength of the instability-death relationship is somewhat stronger pre-PPS than post-PPS. A survival analysis of 90 days postdischarge using a Cox model and controlling explicitly for length of stay and sickness at admission is shown in Table 6.10. In Table 6.10 we see that a patient with congestive heart failure discharged unstable in the pre-PPS period is 1.92 times as likely to die (in log terms, i.e., the ratio of the mortality rate is such that its log is 0.54) than is the patient discharged stable. Similarly, a patient with congestive heart failure discharged unstable in

Table 6.4

30-DAY POSTDISCHARGE MORTALITY RATES FOR PATIENTS WITH AND WITHOUT INSTABILITY, BY PPS PERIOD[a]
(In percent)

	CHF			AMI			PNE		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	11.6	5.9	+5.7*	6.6	3.8	+2.8	9.5	1.7	+7.8*
Post-PPS	8.9	6.1	+2.8	7.4	4.8	+2.6	6.9	4.9	+2.0
All	10.0	6.0	+4.0*	7.0	4.3	+2.7	8.1	3.3	+4.8*

	CVA			HIP			5 Diseases[b]		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	7.0	4.0	+3.0*	7.8	2.5	+5.3*	8.5	3.6	+4.9*
Post-PPS	9.5	4.1	+5.4*	4.3	2.5	+1.8	7.4	4.5	+2.9*
All	8.5	4.0	+4.5*	5.8	2.5	+3.3*	7.9	4.0	+3.9*

NOTE: * = $p < 0.05$ (either direction) for comparison of mortality rates in patients with and without instability.

[a] Sample excludes patients with inhospital death, DNR orders (ever written during the hospital stay), and transfers to acute care hospitals regardless of whether patient is discharged to home or to an institution.

[b] Relative risk of death for pre-PPS compared with post-PPS patients in five diseases combined is 1.69.

Table 6.5

90-DAY POSTDISCHARGE MORTALITY RATES FOR PATIENTS DISCHARGED WITH AND WITHOUT INSTABILITY, BY PPS PERIOD[a]

(In percent)

	CHF			AMI			PNE		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	23.2	15.2	+8.0*	10.5	7.7	+2.8	15.9	7.1	+8.8*
Post-PPS	19.9	13.4	+6.5*	9.5	10.5	-1.0	15.7	10.7	+5.5
All	21.3	14.3	+7.0*	9.9	9.1	+0.8	15.8	8.9	+6.9*

	CVA			HIP			5 Diseases[b]		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	19.1	8.9	+10.2*	16.0	6.5	+9.5*	16.9	9.1	+7.9*
Post-PPS	17.7	10.0	+7.7*	10.4	5.9	+4.5*	14.6	10.1	+4.6*
All	18.3	9.5	+8.8*	12.8	6.2	+6.6*	15.6	9.6	+6.0*

Relative Risk[b] = 1.7

NOTE: * = $p < 0.05$ (either direction) for comparison of mortality rates in patients with and without instability.

[a] Sample excludes patients with inhospital death, DNR orders (ever written during the hospital stay), and transfers to acute care hospitals regardless of whether patient is discharged to home or to an institution.

[b] Relative risk of death for pre-PPS compared with post-PPS patients in five diseases combined.

the post-PPS period is 31 percent more likely to die than is the patient discharged stable. The data suggest some change in the relationship between instability and postdischarge mortality across time periods. The relationship differs across disease but is insignificant for each disease. However, the t for interaction is in the same direction for each disease. For the five diseases combined, the post-PPS relationship between instability at discharge and postdischarge mortality is significant ($t = -2.15$). Possible reasons for this are discussed in Sec. VIII.

For example, Table 6.11 shows that unstable patients with congestive heart failure in the pre-PPS period were 1.88 times as likely to die within 90 days of admission as stable patients. Table 6.11 shows a survival analysis to 90 days postadmission, using a proportional hazards (Cox) model in which patients come into the risk set when they are discharged from the hospital.

Tables 6.5 through 6.11 show that instability at discharge results in increased mortality in both the pre-PPS and post-PPS periods for all five study diseases. This effect appears to be somewhat reduced in the post-PPS period.

Table 6.12 shows the frequency of instability problems in the pre- and post-PPS periods. We call attention to this here because an argument could be put forward that the changes in instability are due to differences in styles of recording or documentation in the post-PPS period compared with the pre-PPS period. However, the data do not support this. When we group the variables into two sets—one recording-sensitive (symptoms) and one recording-insensitive (vital signs)—we find that the recording-insensitive measures actually increased at a higher rate than the sensitive ones. The relative risk for instability at discharge post-PPS compared with pre-PPS is 1.3 for symptoms and 1.4 for signs (Table 6.13). The relative

Table 6.6

30-DAY POSTDISCHARGE MORTALITY RATES FOR PATIENTS DISCHARGED TO HOME WITH AND WITHOUT INSTABILITY, BY PPS PERIOD[a]

Mortality rate 30 days postdischarge

	CHF					AMI					PNE				
	Instability		No Instability		Difference	Instability		No Instability		Difference	Instability		No Instability		Difference
Period	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)
Pre-PPS	99	7.1	751	5.1	+2.0	65	6.2	740	3.1	+3.1	83	9.6	684	0.9	+8.7*
Post-PPS	151	7.3	807	4.8	+2.5	87	6.9	713	4.8	+2.1	98	1.0	638	2.7	−1.7
All	250	7.2	1,558	4.9	+2.3	152	6.6	1,453	3.9	+2.7	181	5.0	1,322	1.7	3.3*

	CVA					HIP					5 Diseases				
	Instability		No Instability		Difference	Instability		No Instability		Difference	Instability		No Instability		Difference
Period	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)
Pre-PPS	62	6.5	441	1.8	+4.7*	37	5.4	424	1.2	+4.2	346	6.1	3,040	2.2	+3.9*
Post-PPS	87	12.6	455	1.8	+10.8*	74	1.4	383	1.3	+0.1	497	5.1	2,996	2.8	+2.3*
All	149	10.1	896	1.8	+8.3*	111	2.7	807	1.2	+1.5	843	5.5	6,036	2.5	+3.0

Relative Risk[b] = 1.7

NOTE: * = $p < 0.05$ (either direction) for comparison of mortality rates in patients with and without instability.

[a] Sample excludes patients with inhospital death, DNR orders (ever written during the hospital stay), and transfers to acute care hospitals regardless of whether patient is discharged to home or to an institution.

[b] Relative risk of death for pre-PPS compared with post-PPS patients in five diseases combined.

Table 6.7

90-DAY POSTDISCHARGE MORTALITY RATES FOR PATIENTS DISCHARGED TO HOME WITH AND WITHOUT INSTABILITY, BY PPS PERIOD[a]

Mortality rate 90 days postdischarge

	CHF					AMI					PNE				
	Instability		No Instability		Difference	Instability		No Instability		Difference	Instability		No Instability		Difference
Period	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)
Pre-PPS	99	20.2	751	14.4	+5.8	65	9.2	740	6.2	+3.0	83	15.7	684	4.2	+11.5*
Post-PPS	151	16.6	807	11.3	+5.3	87	8.0	713	10.2	−2.2	98	6.1	638	7.5	−1.4*
All	250	18.0	1,558	12.8	+5.2*	152	8.6	1,453	8.2	+0.4	181	10.5	1,322	5.8	+4.7*

	CVA					HIP					5 Diseases				
	Instability		No Instability		Difference	Instability		No Instability		Difference	Instability		No Instability		Difference
Period	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)	(n)	(%)	(n)	(%)	(%)
Pre-PPS	62	16.1	441	4.3	+11.8*	37	8.1	424	3.3	+4.8	346	12.3	3,040	5.9	+6.4*
Post-PPS	87	14.9	455	5.7	+9.2*	74	6.8	383	3.1	+3.7	497	9.9	2,996	7.2	+2.7*
All	149	15.4	896	5.0	+10.4*	111	7.2	807	3.2	+4.0*	843	10.8	6,036	6.5	+4.3*

Relative Risk[b] = 2.4

NOTE: * = $p < 0.05$ (either direction) for comparison of mortality rates in patients with and without instability.

[a] Sample excludes patients with inhospital death, DNR orders (ever written during the hospital stay), and transfers to acute care hospitals regardless of whether patient is discharged to home or to an institution.

[b] Relative risk of death for pre-PPS compared with post-PPS patients in five diseases combined.

Table 6.8

30-DAY POSTADMISSION MORTALITY RATES FOR PATIENTS DISCHARGED STABLE AND UNSTABLE, BY PPS PERIOD[a]

Mortality rates 30 days postadmission (%)

	CHF			AMI			PNE		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	7.3	3.2	+4.1*	1.3	1.6	–0.3	4.0	0.7	+3.3*
Post-PPS	5.2	3.8	+1.4	2.1	2.5	–0.4	5.7	2.5	+3.2*
All	6.1	3.5	+2.6*	1.8	2.0	–0.2	4.9	1.6	+3.3*

	CVA			HIP			5 Diseases[b]		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	3.2	0.9	+2.3*	3.9	0.7	+3.2*	3.9	1.4	+2.5*
Post-PPS	6.3	2.4	+3.9*	2.5	1.5	+1.0	4.4	2.5	+1.8*
All	5.0	1.7	+3.3*	3.1	1.1	+2.0*	4.2	2.0	+2.2*

Relative Risk[b] = 1.4

NOTE: * = $p < 0.05$ (either direction) for comparison of mortality rates in patients with and without instability.

[a] Sample excludes patients with inhospital death, DNR orders (ever written during the hospital stay), and transfers to acute care hospitals regardless of whether patient is discharged to home or to an institution.

[b] Relative risk of death for pre-PPS compared with post-PPS patients in five diseases combined.

Table 6.9

90-DAY POSTADMISSION MORTALITY RATES FOR PATIENTS DISCHARGED STABLE AND UNSTABLE, BY PPS PERIOD[a]

Mortality rates 90 days postadmission (%)[a]

	CHF			AMI			PNE		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	21.0	12.9	+8.1*	10.5	6.4	+4.1	15.0	6.0	+9.1*
Post-PPS	19.9	12.7	+7.2*	9.5	9.2	+0.3	13.8	9.4	+4.4
All	20.4	12.8	+7.6*	9.9	7.8	+2.1	14.4	7.7	+6.7*

	CVA			HIP			5 Diseases[b]		
Period	Instability	No Instability	Difference	Instability	No Instability	Difference	Instability	No Instability	Difference
Pre-PPS	14.7	7.4	+7.3*	14.1	4.6	+9.5*	15.1	7.5	+7.6*
Post-PPS	15.8	9.1	+6.7*	9.3	5.2	+4.1*	13.7	9.1	+4.5*
All	15.3	8.3	+7.0*	11.3	4.9	+6.4*	14.3	8.3	+6.0*

Relative Risk[b] = 1.7

NOTE: * = $p < 0.05$ (either direction) for comparison of mortality rates in patients with and without instability.

[a] Sample excludes patients with inhospital death, DNR orders (ever written during the hospital stay), and transfers to acute care hospitals regardless of whether patient is discharged to home or to an institution.

[b] Relative risk of death for pre-PPS compared with post-PPS patients in five diseases combined.

Table 6.10

SURVIVAL ANALYSIS FOR PATIENTS WITHIN 90 DAYS POSTDISCHARGE USING COX[a] AND SICKNESS-AT-ADMISSION CONTROLS[b] FOR LENGTH OF STAY[c]

	Log Hazard[d]		
	Pre-PPS	Post-PPS	t for Interaction
Congestive heart failure	0.54	0.31	−0.8
Acute myocardial infarction	0.52	−0.08	−1.1
Pneumonia	0.62	0.31	−0.9
Cerebrovascular accident	0.52	0.29	−0.8
Hip fracture	0.63	0.24	−1.2

[a] Cox model is the proportional hazards model introduced by Cox and explained in Kalbfleish and Prentice (1980).

[b] Controls for length of stay: The model considers only postdischarge information and controls for length of stay using a regression equation.

[c] Adjusted for sickness at admission with sickness-at-admission scale designed to predict death at 30 days postadmission (see Sec. III).

[d] The unit for expressing differences is the log of the hazard rate. For example, for congestive heart failure in the pre-PPS period, unstable patients were exp (0.54) or 1.92 times as likely to die within 90 days of admission as stable patients.

Table 6.11

SURVIVAL ANALYSIS FOR PATIENTS WITHIN 90 DAYS POSTADMISSION USING COX[a] AND SEVERITY CONTROLS[b] FOR LENGTH OF STAY[c]

	Log Hazard[d]		
	Pre-PPS	Post-PPS	t for Interaction
Congestive heart failure	0.63	0.41	−0.8
Acute myocardial infarction	0.65	0.10	−1.1
Pneumonia	0.75	0.27	−1.3
Cerebrovascular accident	0.61	0.30	−1.0
Hip fracture	0.86	0.25	−1.8

[a] The Cox model is the proportional hazards model introduced by Cox and explained in Kalbfleish and Prentice (1980).

[b] Controls for length of stay: The model considers only postdischarge information and controls for length of stay using a regression equation.

[c] Adjusted for sickness at admission with (a) sickness-at-admission scale designed to predict death at 30 days postadmission and with (b) scale designed to measure sickness on the third hospital day.

[d] The unit for expressing differences is the log of the hazard ratio. For example, for congestive heart failure in the pre-PPS period, unstable patients were exp (0.63) or 1.88 times as likely to die within 90 days of admission as stable patients.

increase in the sensitive measures averaged 0.31 (in logs) and the increase in the insensitive measures averaged 0.49.

Table 6.14 shows the hazard ratios and t-statistics for the differences in mortality rates for stable patients pre-PPS and post-PPS. For example, the risk of death for stable patients post-PPS is 92 percent of what it was pre-PPS. The positive sign on the t-statistics means that death rates for stable patients were (insignificantly) higher post-PPS compared with pre-PPS.

Table 6.12

MEASURES OF INSTABILITY AT DISCHARGE FOR THE PRE- AND POST-PPS SAMPLE[a]
(In percent)

Measures of Discharge Instability[b]	CHF		AMI		PNE		CVA		HIP		5 Diseases	
	Pre (n=1,122)	Post (n=1,230)	Pre (n=991)	Post (n=995)	Pre (n=1,073)	Post (n=1,072)	Pre (n=916)	Post (n=1,011)	Pre (n=1,245)	Post (n=1,306)	Pre (n=5,341)	Post (n=5,572)
Fever (temperature > 101°F)	0	0	0.2	1.0	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2
New incontinence	4.1	5.1			5.5	6.1	13.6	17.5*	11.1	13.5	8.5	10.4*
New chest pain	1.7	1.1	0.3	0.2	1.1	1.4			1.9	3.6*	1.3	1.7
New shortness of breath	1.3	1.8	0.9	1.4	1.1	1.8	1.1	1.8	(c)	(c)	1.1	1.7*
New confusion	3.7	5.4	2.3	3.4	2.0	3.0			4.8	6.1	3.3	4.6*
New heart rate ≥ 130	0.3	1.1*	0.1	0.2	0.2	0.8	0.1	0.6	0	0.3*	0.1	0.6*
New respiratory rate ≥ 130	1.2	2.5*	0.7	0.7	1.6	2.1	2.1	1.5	1.2	1.8	1.3	1.8
Diastolic BP > 105	1.2	1.8	0.6	0.4	1.1	1.0	2.5	3.2	0.8	0.5	1.2	1.3
New systolic BP < 90	2.1	2.5	1.9	1.3	0.8	1.7*	1.3	1.5	0.7	0.7	1.3	1.4
New heart rate < 50			1.2	2.5*							1.2	2.5*
New PVC			0.7	1.2							0.7	1.1*
≥ 1 instability	13.5	17.2*	8.5	10.6	12.6	16.0*	6.6	22.6	18.8	23.1*	14.6	18.3*
Mean no. instabilities	0.15	0.21*	0.09	0.11	0.14	0.18	0.07	0.27	0.21	0.27	0.16	0.21*

NOTE: * $p < 0.05$.

[a] Excludes inhospital deaths and transfers to acute care hospitals.

[b] All measures of discharge instability and sickness evaluate the presence of symptoms or signs on the day before discharge or the day of discharge.

[c] For hip fracture patients chest pain is defined as chest pain or shortness of breath.

Table 6.13

SYMPTOMS AND SIGNS OF INSTABILITY AT DISCHARGE PRE- AND POST-PPS

	Pre	Post	Absolute % Change[a]	Relative % Change[b]
Symptoms				
Incontinence	8.5	10.4	+1.9	22.4
Chest pain	1.3	1.7	+0.4	30.8
Shortness of breath	1.1	1.7	+0.6	54.6
Confusion	3.3	4.6	+1.3	39.4
Mean of 4 symptoms	3.6	4.6	+1.1	36.8[c]
Signs				
Fever	0.2	0.2	0	0
Heart rate ≥ 130	0.1	0.6	+0.5	500.0
Respiratory rate ≥ 30	1.3	1.8	+0.5	38.5
Diastolic BP ≥ 105	1.2	1.3	+0.1	8.3
Systolic BP < 90	1.3	1.4	+0.1	7.7
Heart rate < 50	1.2	2.5	+1.3	108.3
PVC	0.7	1.3	+0.4	57.1
Mean of 7 signs	0.9	1.3	+0.4	102.8[d]

[a] Absolute percentage change is calculated as percent of patients with symptom or sign (post-PPS)–(pre-PPS).

[b] Relative percent change is calculated as percent of patients with symptom or sign (post-PPS)–(pre-PPS)/pre-PPS.

[c] Relative risk for symptoms of instability at discharge post-PPS compared with pre-PPS is 4.6/3.6 = 1.3.

[d] Relative risk for signs of instability at discharge post-PPS compared with pre-PPS is 1.3/0.9 = 1.4.

Having established that instability at discharge is a measure whose properties are of interest to clinicians and policymakers—it is not just another measure of severity at admission; neither does it represent a general measure of inhospital process; and it is associated with higher likelihood of postdischarge death—we can now consider instability at discharge before and after PPS (Table 6.15). Post PPS, instability at discharge increased 22 percent. Before implementation of PPS, 15 percent of people were discharged unstable, whereas afterward, 18 percent were discharged unstable. Most of the increase in instability was concentrated in those people discharged to home. In particular, across all conditions, institutions did not receive a significantly greater number of unstable patients (22 percent pre-PPS and 23 percent post-PPS—an insignificant relative increase of 3 percent). On the other hand, a patient discharged to home post-PPS was 43 percent more likely to be unstable than before PPS. This finding is consistent across conditions for patients discharged to home, with the biggest change occurring among hip fracture patients (9 percent discharged to home were unstable before PPS, 17 percent so discharged after PPS—a 93 percent change).

Table 6.16 shows mean length of stay for patients discharged with and without instability in the pre- and post-PPS periods. Length of stay is slightly longer for patients with instability than for those without instability. However, the difference in length of stay for stable and unstable patients drops from 1.06 days pre-PPS to 0.30 days post-PPS suggesting that

Table 6.14

DIFFERENCES IN MORTALITY RATES FOR STABLE PATIENTS PRE- AND POST-PPS

Disease	Log Hazard[a]	t[b]
CHF	-0.08	-0.6
AMI	0.30	1.6
PNE	0.29	1.6
CVA	0.21	1.1
HIP	-0.07	-0.4

[a] The unit for expressing the difference is the log of the hazard rates. For example, for stable congestive heart failure patients, the rate of death post-PPS is exp (-0.08) or 92 percent as high as the rate of death for stable patients pre-PPS.

[b] The t shows an insignificant difference between the mortality rates for stable patients pre-PPS compared with post-PPS.

hospitals in the post-PPS period may be paying less attention to unstable patients. Table 6.17 shows length of stay effects for unstable compared with stable patients adjusting for sickness at admission (which did not have a large effect). Table 6.17 shows the same findings as Table 6.16; the negative sign on t for interactions for four of the five diseases again shows that length of stay is somewhat shorter for unstable patients post-PPS compared with pre-PPS.

We have elected to focus on postdischarge data rather than postadmission data as the outcome of interest in this section because it is simple. In addition, the variable of interest, unstable discharge, happens only at the end of the hospitalization. It violates regression assumptions about correlation between the independent variable and the error term (the randomness of death or nondeath in the hospital) to analyze a postadmission outcome that has partially preceded the end of the hospitalization. As noted in Tables 6.4, 6.5, 6.8, and 6.9, it makes little difference whether we use postadmission or postdischarge as the outcome measure. (Note that the sample for the postadmission data (Tables 6.8 and 6.9) excludes patients with inhospital death, since the analysis would not otherwise make sense).

DISCUSSION

Other sections in this report have demonstrated that the introduction of PPS was not associated with a rise in either short-term (30-day) mortality or six-month mortality. In light of these findings, how important is the finding that instability at discharge has increased since the advent of PPS? The answer depends on one's vantage point. We will consider briefly the perspectives of the patient, the family, the geriatrician, the hospital, the nursing home, and finally the policymaker.

From the patient's and family's point of view, it must be comforting to know that the overwhelming majority of patients (85 percent post-PPS) discharged to home leave the hospital in a stable condition. The percentage of patients discharged to home with an instability, however, has increased. Because the major causes of these instabilities are clinically

Table 6.15

RELATIONSHIP OF PPS TO INSTABILITY AT DISCHARGE, BY DISCHARGE DESTINATION[a]
(In percent)

Disease	Discharge Destination[b]	Unstable at Discharge		Absolute Change Pre-Post	Relative Change Pre-Post
		Pre-PPS	Post-PPS		
CHF	All Patients	13.6	17.1*	+ 3.5	+ 25
	Home	11.7	16.3**	+ 4.6	+ 39
	Institution	23.9	21.2*	- 2.7	- 11
AMI	All Patients	8.5	10.6	+ 2.1	+ 25
	Home	8.2	10.8	+ 2.6	+ 32
	Institution	11.9	8.3	- 3.6	- 30
PNE	All Patients	12.6	16.0*	+ 3.4	+ 27
	Home	10.6	13.4	+ 2.8	+ 27
	Institution	18.6	23.4	+ 4.8	+ 26
CVA	All Patients	19.0	23.4*	+ 4.4	+ 23
	Home	12.2	16.0	+ 3.8	+ 31
	Institution	30.1	33.5	+ 3.4	+ 11
HIP	All Patients	18.8	23.1**	+ 4.3	+ 23
	Home	8.8	17.0**	+ 8.2	+ 93
	Institution	25.7	26.9	+ 1.2	+ 4
5 Diseases	All Patients	15.0	18.3**	+ 3.3	+ 22
	Home	10.3	14.7**	+ 4.4	+ 43
	Institution	22.0	22.7	+0.7	+3

NOTE: * $p < 0.05$, ** $p < 0.01$; for chi-square test of pre-post differences in instability at discharge for all patients, for those discharged home, and for those discharged to an institution.

[a] Patients with inhospital death, DNR orders, or transfer to acute care hospitals are excluded from this analysis.

[b] Discharge destination for all patients means that this line refers to all sample patients regardless of discharge destination.

important, the amount of support needed at home has increased. Being discharged to home unstable with confusion or incontinence at best is an inconvenience for the family and at worst may expose the patient to an increased risk of death.

Elderly patients being discharged unstable suffer from those conditions that geriatricians have been calling attention to for years, namely, incontinence and confusion. For example, taking pre- and post-PPS together, 10 percent of patients were discharged with new incontinence that was not present at admission and 4 percent had new confusion. These findings raise questions such as: Are increases in instability caused by inappropriately early discharges, too many tests in a shortened hospital stay, incorrect use of new medications, or changes in nursing practice (e.g., fewer nurses per patient and less time available to talk with the patient or monitor incontinence or disorientation)? The answers to these questions require new data, perhaps clinical trials and the development of valid disease-specific discharge guidelines.

From a hospital or nursing home perspective, our results are both encouraging and potentially disturbing. Instability among patients who were not assigned DNR status and who were discharged to nursing homes has not increased post-PPS. On the other hand, the

Table 6.16

MEAN LENGTH OF STAY FOR UNSTABLE AND STABLE PATIENTS, BY PPS PERIOD

Mean length of stay (days)

	CHF			AMI			PNE		
Period	Instability	No Instability	Difference by Instability[a]	Instability	No Instability	Difference by Instability[a]	Instability	No Instability	Difference by Instability[a]
Pre-PPS	11.0	11.1	0	14.9	15.0	-0.1	13.0	12.2	+0.8
Post-PPS	8.5	8.6	-0.1	13.3	12.2	+1.1	9.3	10.2	-0.9
All	9.5	9.8	-0.3	14.0	13.7	+0.3	10.9	11.2	-0.3
Difference by PPS Period[b]	2.5	2.5	0	1.6	2.8	-1.2	3.7	2.0	1.7

	CVA			HIP			5 Diseases		
Period	Instability	No Instability	Difference by Instability[a]	Instability	No Instability	Difference by Instability[a]	Instability	No Instability	Difference by Instability[a]
Pre-PPS	20.1	16.5	+3.6	20.9	19.9	+1.0	16.0	14.9	+1.06
Post-PPS	12.0	10.5	+1.5	14.2	14.3	-0.1	11.5	11.2	+0.30
All	15.4	13.5	+1.9	17.1	17.1	0	13.4	13.1	+0.32
Difference by PPS Period[b]	8.1	6.0	2.1	6.7	5.6	1.1	4.5	2.7	1.8

[a] Difference by instability is (LOS for unstable patients) – (LOS for stable patients).

[b] Difference by PPS period is (LOS for pre-PPS patients) – (LOS for post-PPS patients).

Table 6.17

LENGTH OF STAY EFFECTS FOR UNSTABLE COMPARED WITH STABLE PATIENTS

	Log Hazard Ratio[a]		
	Pre	Post	t for Interaction
CHF	-0.07	-0.09	-0.2
AMI	-0.00	+0.02	+0.3
PNE	-0.05	-0.10	-0.8
CVA	+0.14	+0.10	-0.6
HIP	+0.03	+0.01	-0.3

[a] Log hazard ratio describes the relative likelihood of discharge on a given day after admission. The numbers in the table represent the relative risk of discharge with instabilities as compared with stable dicharges, censoring at the date of death. For example, for congestive heart failure in the pre-PPS period, unstable patients were exp (-0.07) or 93 percent as likely to be discharged on a given day as stable patients.

observation that one-quarter of nursing home patients are admitted with an instability is a disquieting finding. Is the hospital discharge planning process adequate to handle the smooth transition of these patients to institutions, and is the nursing home reimbursement level sufficient to provide adequate care for them? In particular, do nursing home physicians know of these problems, are they noted in the clinical record sent to the nursing home, and do nursing home nurses and physicians develop an adequate strategy to address them?

These data might justifiably be greeted as an additional burden placed at the hospital administrator's doorstep. That may be the case, but because instability is linked to subsequent death and results in decreased quality of life, this issue needs to be addressed. Learning at the hospital level what causes instability at discharge and how to reduce it should become a major administration and medical staff. Either decreasing instability at discharge to zero or developing postdischarge plans to eliminate its effects could become part of a hospital's continuous improvement effort. It might also receive emphasis in an accreditation program such as that sponsored by the Joint Commission for Accreditation of Health Care Organizations.

Finally, from a policy perspective, these results raise concerns about what information is needed to monitor a change in health policy and how often data on instability at discharge should be collected. The data in this report are now four years out of date, and during that time hospitals have received less generous levels of reimbursement. We have demonstrated a problem that has been apparent since at least 1981: Patients discharged to home in an unstable condition have a greater than average expected risk of dying and probably need more family support. In addition, we have demonstrated that the risk of being discharged unstable has increased since PPS was implemented. Reducing the effect of instability may be possible even without increasing hospital length of stay, but this will require examining, with the aid of clinical data, the impact of various policy options on instability's occurrence and outcome.

VII. COMPARING OUTCOMES OF CARE PRE- AND POST-PPS

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Given that the main goal of the medical system is to produce better patient outcomes, any evaluation of PPS must closely examine what happens to patients as a function of the care they receive. To evaluate whether patient outcomes have changed after the implementation of the combined PPS/PRO system, we conducted an observational study in which we compared outcomes before and after PPS was introduced. It was not enough to compare raw outcomes, however; we had to account in addition for differences pre- compared with post-PPS in patient characteristics at the time of admission. This was particularly important because sickness at admission, a strong predictor of outcomes, changed noticeably during the period we studied (Sec. III).

In this section we report on changes in length of stay; in mortality, adjusted for sickness at admission, both during the hospital stay and within 30 and 180 days of admission; in discharge to home or to an institution following hospitalization; in prolonged nursing home stay; and in hospital readmissions. Of our three mortality outcomes, only inhospital death is available from medical record review. Inhospital mortality, however, provides a distorted view of changes in outcomes over time, because length of stay has declined post-PPS, reducing the period of observation for inhospital deaths (Jencks et al., 1988). We have therefore studied both inhospital mortality and mortality at fixed times after hospital admission (30 and 180 days). We have included outcomes other than mortality to provide a more comprehensive look at what happened to patients.

METHODS

Measuring Sickness at Admission

To take account of patients' sickness at admission, we collected 60–80 disease-specific variables from the medical record that described the patient's acute and chronic morbid and comorbid conditions (Kahn et al., 1988b; Rubenstein et al., 1988; Kosecoff et al., 1988; Sherwood et al., 1988; and Roth et al., 1988). Using these data we developed disease-specific sickness-at-admission scales and used them to adjust outcomes for patient sickness at admission. Details on how this was done are provided in Sec. III.

Measuring Mortality

We used the medical record as our source of inhospital mortality information, and already existing HCFA files to determine mortality status after the patient's discharge. By using the patient's last name, first name, date of birth, and Health Insurance Claim (HIC) number from the medical record, we were able to accurately match 92 percent of the patients in our study sample to the HCFA Health Insurance Master (HIM) file.

We tried to ascertain whether the 8 percent of patients we could not match were different in important ways from the other 92 percent of patients. Using the medical record data, 61 percent of the unmatched patients were from the pre-PPS period and 39 percent were from the post-PPS period. In the pre-PPS period 20 percent of unmatched patients died in the hospital, whereas in the post-PPS period 19 percent had died inhospital. The unmatched patients were sicker on average than were matched patients, but the distributions of sickness at admission among the unmatched patients were similar in the pre- and post-PPS periods, so that any effects arising from this disparity will approximately cancel in the comparisons. (See App. F for further details about using mortality data from the HIM file.)

We assessed short-term mortality by studying both inhospital mortality and death within 30 days of the acute care admission. To determine an appropriate measure of medium-term mortality, we regressed death from 30 to 90 days, 91 to 180 days, 181 to 270 days, and 271 to 365 days on process, sickness at admission, and instability at discharge. Sickness at admission was an important predictor for all four death period outcomes, but process and instability at discharge were only significant up to 180 days. This indicates that differences in effects of care on death during an acute hospitalization may attenuate after 180 days. We therefore chose death within 180 days postadmission as our indicator of medium-term mortality.

Measuring Preadmission Residence and Discharge Destination

We used the medical record as the source of both the patient's preadmission residence and discharge destination, labeling origin or destination "home" if so indicated in the physicians', nurses', or therapists' notes or in administrative data. For both origin and destination we defined "nursing home" as a skilled nursing facility, intermediate care facility, extended care facility, or a nursing home without other description. We listed retirement homes, sheltered housing, congregate housing, halfway housing, and board and care facilities separately.

Measuring Prolonged Nursing Home Stay

The only available data source for studying duration of stay in a nursing home is Medicare's Part B files of physician bills. When a physician bills for a nursing home visit, either the place of service is designated as a nursing home or a special procedure code is used. We were able to collect these kinds of data for patients in three of the five study states.

In States A and B, we report only the number of patients for whom a bill was submitted, during months 5, 6, or 7 after admission, for a visit to a skilled nursing home or other (residential) nursing home, without differentiating between the two. In State C we report the number of patients for whom a bill was submitted for a visit to a skilled nursing facility only. We report the data for the states separately, because of differences in the way state-specific carriers categorized physician bills, and we then give average values for the three states combined.

To investigate the validity of this method for studying prolonged nursing home stays, we determined how often patients whose inhospital medical records indicated that they were discharged to a nursing home had any physician bill from a nursing home during the three months following discharge. In the three study states, we found that 90 percent, 86 percent, and 84 percent, respectively, of patients discharged to a nursing home had evidence for such a physician bill. We then determined the number of patients who were alive seven months after the acute care hospital admission and who also had a bill submitted by a physician for a visit to a nursing home within five, six, or seven months after hospital admission.

Measuring Readmissions

To study readmissions we used the patients we matched to the HIM file (previously described under postdischarge mortality) and matched them to HCFA's Bill Retrieval file. Of the 92 percent of patients for whom we had accurate mortality data, we were able to accurately match 95 percent in the Bill Retrieval file, for an overall readmission matching success rate of 87 percent. Specifically, we were unable to find any bill for 4.4 percent of patients we studied and we were unable to find the study hospitalization bill, but could find subsequent hospital bills, for 1 percent of the sample. The resulting file allowed us to measure both the incidence of a readmission within 180 and 365 days postadmission and the length of stay for all acute care hospitalizations. We included readmissions to all acute care hospitals regardless of the reason for readmission or the relationship between the readmission and the initial hospitalization.

Adjusting Outcomes for Sickness at Admission

For all comparisons of outcomes before and after PPS except as noted below, we used the 30- and 180-day sickness-at-admission scales to adjust for differences in sickness at the time of hospital admission (Sec. III). For length of stay, unadjusted and adjusted results are similar, and we present unadjusted data. For 30-day postadmission mortality, we adjusted pre- compared with post-PPS differences using the disease-specific scales designed to predict death within 30 days of admission. For 180-day postadmission mortality, prolonged nursing home stay, and hospital readmissions, we adjusted using the scales designed to predict death as of both 30 and 180 days after admission. In all cases where adjustment was performed, our method of adjustment was regression; for example, to compute pre- and post-PPS 30-day mortality adjusted for sickness at admission, we regressed 30-day mortality on a pre- post-PPS indicator variable and the 30-day sickness scales, and computed adjusted mortality rates pre- and post-PPS from this regression. For discharge destination, we adjusted outcomes using both the 30-day and 180-day sickness-at-admission scales reported in Sec. III to predict mortality and special scales to predict discharge to a skilled nursing facility. (See App. F for the description of scales to predict discharge to a skilled nursing facility.) Neither affected the comparisons of discharge destination pre- and post-PPS, and we present the discharge destination results without adjustment for sickness at admission.

RESULTS

Length of Stay

For each disease studied we found a substantial reduction in length of stay (see Table 7.1). The reduction was 21 percent for congestive heart failure, 18 percent for acute myocardial infarction, 14 percent for pneumonia, 32 percent for cerebrovascular accident, and 28 percent for hip fracture. Overall, across the five diseases, we found a 24 percent reduction

Table 7.1

MEAN LENGTH OF STAY IN DAYS[a,b] BEFORE AND AFTER PPS, BY DISEASE

Disease	n	Pre-PPS	Post-PPS	Difference
CHF	2,824	11.1	8.8	-2.3*
AMI	2,853	12.7	10.4	-2.3*
PNE	2,749	12.1	10.4	-1.7*
CVA	2,824	16.2	11.1	-5.1*
HIP	2,762	20.1	14.5	-5.6*
5 diseases	14,012	14.4	11.0	-3.4*

NOTE: * $p < 0.001$ for comparison of length of stay pre-PPS compared with post-PPS.

[a] Unadjusted for sickness at admission. Such adjustment had little effect (see the text).

[b] If patient was discharged to a nonacute or swing hospital bed, patient was considered discharged.

(3.4 days) in length of stay. For patients discharged alive, length of stay fell 26 percent, and for patients with inhospital death, length of stay fell 15 percent post-PPS compared to pre-PPS for the five diseases combined. (Appendix F presents data for mean length of stay pre- and post-PPS after adjustment for sickness at admission.)

Mortality

After adjustment for sickness at the time of hospital admission, we found a reduction in inhospital mortality after the introduction of prospective payment for all five diseases. Adjusted inhospital mortality for the five diseases combined dropped from 16.1 percent to 12.8 percent (Table 7.2). The 3.3 percentage point reduction in inhospital mortality (95 percent confidence interval, 2.3 percent to 4.3 percent) was significant ($p < 0.01$) as was the reduction in mortality for four of the five diseases.

When we studied mortality in a fixed time period after hospital admission, adjusted mortality rates for all five diseases remained lower post-PPS compared with pre-PPS. However, the relationship was no longer statistically significant at the 0.01 level. Unweighted adjusted mortality rates 30 days after admission for the five diseases combined were 16.7 percent pre-PPS and 15.7 percent post-PPS, a difference of 1.0 percentage points (95 percent confidence interval, -0.1 percent to 2.1 percent, $p = 0.07$). After reweighting the sample to represent the nation, the 30-day postadmission adjusted mortality rates were slightly different from the unweighted values (16.5 percent pre-PPS compared with 15.4 percent post-PPS, difference 1.1 percentage points, $p = 0.04$).

As of 180 days postadmission, the adjusted mortality rates for the five diseases combined were 29.6 percent pre-PPS and 29.2 percent post-PPS. Thus, almost one-third of Medicare patients hospitalized with the five study diseases have expired within six months after admission. For congestive heart failure, cerebrovascular accident, and hip fracture mortality dropped (significantly for hip fracture: 17.8 percent pre-PPS, 14.8 percent post-PPS, $p < 0.05$); for acute myocardial infarction and pneumonia mortality rose post-PPS. Figure 7.1 shows survival curves adjusted for sickness at admission for each of the five study diseases. The pre- and post-PPS curves are similar for all conditions.

Table 7.2

ADJUSTED MORTALITY RATES BEFORE AND AFTER PPS, BY DISEASE AND TYPE OF MORTALITY MEASURE[a]
(In percent)

	CHF		AMI		PNE		CVA		HIP		5 Diseases	
Mortality Adjusted for Sickness at Admission	Pre n=1,359	Post n=1,465	Pre n=1,416	Post n=1,437	Pre n=1,341	Post n=1,408	Pre n=1,382	Post n=1,442	Pre n=1,358	Post n=1,404	Pre n=6,856	Post n=7,156
Inhospital	12.3	8.9**	24.0	21.8+	15.5	12.6*	22.4	17.8**	5.7	3.3**	16.1	12.8**
30-day postadmission	14.7	13.0	24.2	24.2	15.9	15.7	21.3	19.9	5.3	4.6	16.7	15.7+[b]
180-day postadmission	33.5	31.7	33.6	34.8	27.8	29.2	35.3	34.3	17.9	14.8*	29.6	29.0

NOTE: ** $p < 0.01$, * $p < 0.05$, + $p = 0.05 - 0.09$

[a] Inhospital and 30-day postadmission mortality rates are adjusted for sickness at admission using scales designed to predict death at 30 days postadmission. 180-day postadmission mortality rates are adjusted using scales designed to predict death at 180 days postadmission.

[b] As noted in the Methods section above, these data are unweighted. Reweighting for national representativeness changes the 30-day postadmission mortality rates for the five diseases combined as follows: 16.5 percent pre-PPS, 15.4 percent post-PPS ($p = 0.04$). This is the only outcome comparison whose significance is affected by the reweighting.

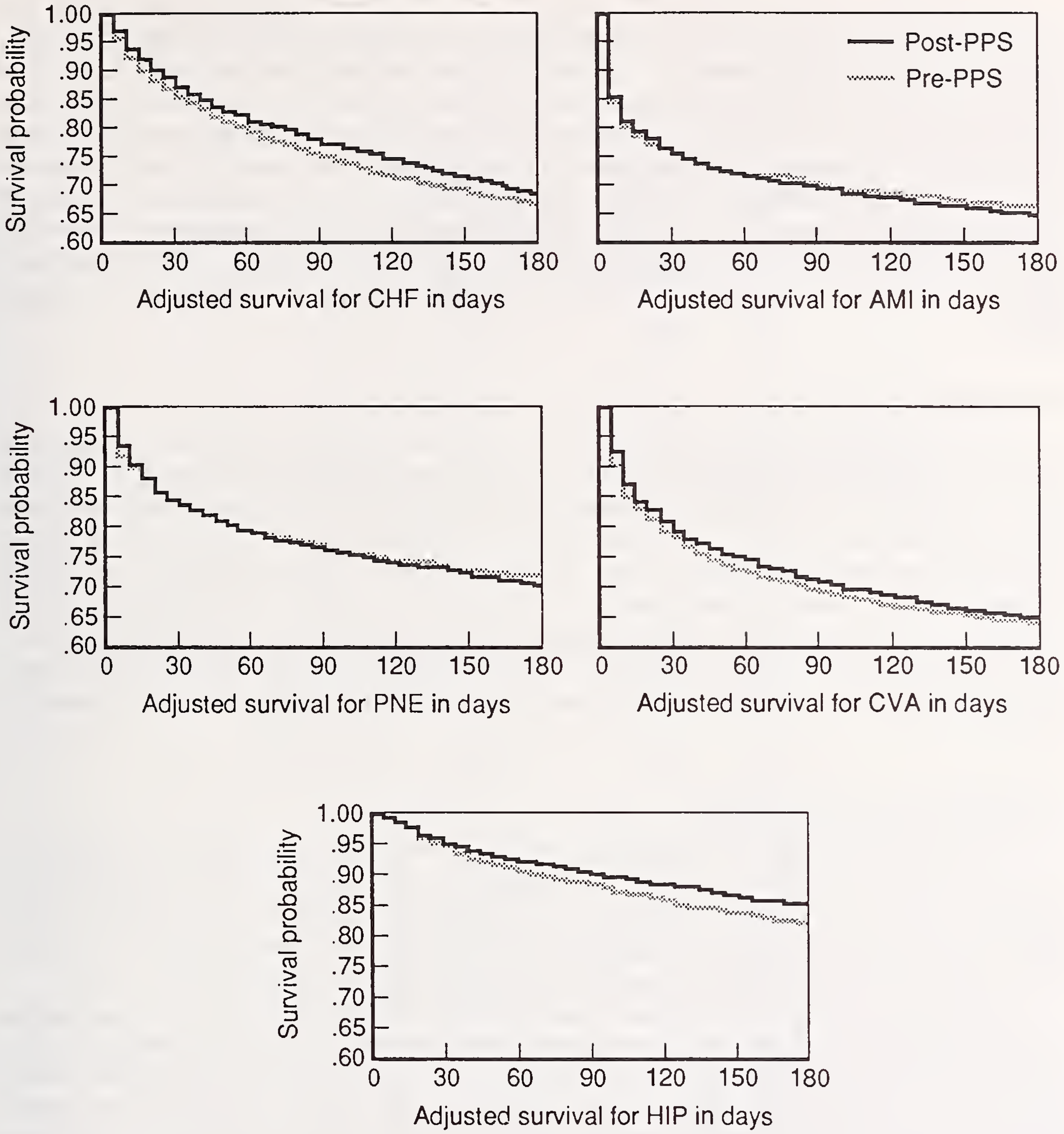

Fig. 7.1—Survival curves comparing mortality following hospital admission through 180 days pre- and post-PPS for five diseases

For all five diseases we found that patients who were admitted from home but discharged to an institution (e.g., a nursing home) had a higher adjusted mortality rate than did patients discharged to home. For example, 180-day postadmission mortality for the five diseases combined, adjusted for sickness at admission, for patients coming from home and discharged alive, was 14 percent for patients discharged home and 23 percent for patients transferred to an institution. The adjusted 180-day postadmission mortality rate for patients living in a skilled nursing facility before and after the initial study hospitalization was 33 percent. Although mortality rates differ significantly ($p < 0.05$), comparisons of mortality rates pre- and post-PPS after controlling for discharge destination do not show significant differences. (Appendix F presents additional mortality data pre-PPS compared with post-PPS.)

Discharge Destination

For the five diseases combined the fraction of patients with a preadmission residence of home and a discharge destination of home was 77 percent pre-PPS and 73 percent post-PPS ($p < 0.05$), with the most important difference being for hip fracture patients (56 percent pre-PPS and 48 percent post-PPS, $p < 0.05$, Table 7.3). We found little change in the discharge destination for patients admitted from a nursing home. Overall, 95 percent of patients admitted from a nursing home returned to a nursing home, and this did not vary significantly by disease or time period. (Appendix F shows the frequency with which patients with a preadmission residence of home or nursing home have various discharge destinations in the pre- compared with the post-PPS periods with and without adjustment for sickness at admission.)

Prolonged Nursing Home Stay

In studying prolonged nursing home stay, we focused on patients whose preadmission residence was home and who were still alive seven months after the study hospitalization. For the five diseases combined, 8 percent of such patients in States A and B were in some type of a nursing home approximately six months after the acute hospitalization, whereas 2 percent of such patients in State C were in a skilled nursing home (Table 7.4).

In all three states, somewhat more patients had prolonged nursing home stays during the post-PPS period. Across the three states we found that 5.6 percent of patients in the pre-PPS period and 6.6 percent of patients in the post-PPS period had prolonged nursing home stays ($p > 0.05$). This finding was not statistically significant in any state. (Appendix F presents more details about the methods and results for the study of prolonged nursing home stays.)

Readmissions

We found that the number of patients who died within 180 days of admission for the five diseases combined or who had at least one readmission was unchanged during the two time periods: 57 percent pre-PPS and 56 percent post-PPS ($p > 0.05$, Table 7.5). Results varied slightly by disease, with fewer congestive heart failure, pneumonia, and hip fracture patients post-PPS having either a death or a readmission ($p > 0.05$) but more patients with acute myocardial infarction suffering one of these two outcomes post-PPS ($p < 0.05$).

Table 7.3

DISCHARGE DESTINATION FOR PATIENTS, BY DISEASE AND PREADMISSION RESIDENCE

(In percent)

	CHF		AMI		PNE		CVA		HIP		5 Diseases	
	Pre n=1,007	Post n=1,133	Pre n=960	Post n=990	Pre n=853	Post n=875	Pre n=922	Post n=1,005	Pre n=894	Post n=987	Pre n=4,636	Post n=4,990
Admitted from and discharged to home	90	88	87	83*	92	88*	60	58	56	48*	77	73*
	CHF		AMI		PNE		CVA		HIP		5 Diseases	
	Pre n=82	Post n=99	Pre n=32	Post n=39	Pre n=204	Post n=268	Pre n=90	Post n=114	Pre n=301	Post n=263	Pre n=709	Post n=783
Admitted from and discharged to nursing home	93	97	94	92	94	94	91	95	97	98	95	96

NOTES: * $p < 0.05$. The entries in this table represent the number of patients discharged to each destination divided by the number of patients discharged alive, among those admitted from the indicated origin.

Table 7.4

PERCENTAGE OF PATIENTS IN NURSING HOMES SIX MONTHS FOLLOWING HOSPITAL ADMISSION AND ALIVE SEVEN MONTHS AFTER HOSPITALIZATION, BY STATE AND DISEASE PRE- AND POST-PPS[a]

	State A[b]			State B[b]			State C[b]		
Disease	n[c]	Pre	Post	n[c]	Pre	Post	n[c]	Pre	Post
Congestive heart failure	269	5.1	4.6	260	5.0	5.0	260	0.8	2.2
Acute myocardial infarction	280	1.4	2.9	267	1.6	0.0	269	0.0	2.0
Pneumonia	240	4.8	7.8	236	3.4	4.3	259	1.7	2.2
Cerebrovascular accident	275	10.9	18.1	265	19.0	18.1	250	6.0	4.5
Hip fracture	302	10.7	12.4	263	10.7	12.0	271	2.6	1.9
5 diseases	1,366	6.7	9.2	1,291	7.9	8.1	1,309	2.2	2.5

[a] The entries in this table represent the number of patients with evidence for physician nursing home bills submitted within five, six, or seven months after admission divided by the number of patients alive seven months after admission. This analysis includes only patients with preadmission residence of home. None of the differences were significant at $p < 0.05$.

[b] Each fiscal carrier providing data for this analysis offered the data in a different format. For States A and B, the table compares the percentages of patients with evidence for prolonged nursing home stay, indicated by a physician bill, to a skilled nursing or other (residential) nursing home. For State C, the table compares the percentages with evidence for prolonged nursing home stay, as indicated by a physician bill, to a skilled nursing facility only.

[c] Pre- and post-PPS sample combined.

As of 365 days postadmission, the proportion of those patients discharged alive who had at least one hospital readmission was lower post-PPS for all diseases except acute myocardial infarction, and lower for the five diseases combined ($p < 0.05$ for congestive heart failure, hip fracture, and overall). Across all diseases except acute myocardial infarction, the total number of days spent inhospital within one year of the study hospitalization was significantly lower post-PPS than pre-PPS ($p < 0.05$ for congestive heart failure, pneumonia, hip fracture, and the five diseases combined).

Summarizing Comparisons of Outcomes Pre- and Post-PPS

Table 7.6 summarizes our outcome findings. For the five diseases combined, inhospital mortality was 3 percentage points lower post-PPS compared with pre-PPS ($p < 0.01$). However, this post-PPS improvement in mortality decreased to 1.1 percentage points by 30 days postadmission and was gone by 180 days postadmission.

For patients admitted to the hospital from home, for the five diseases combined, we found that 4 percent more patients post-PPS were not discharged to home ($p < 0.05$). We found that an additional 1 percent (0 – 3 percent depending on the state) of patients with a preadmission residence of home had evidence for a prolonged nursing home stay ($p > 0.05$). For the five diseases combined, the proportion of patients with one or more readmissions within one year of the initial hospitalization was 3 percentage points lower post-PPS than pre-PPS ($p < 0.05$).

Table 7.5

HOSPITAL READMISSIONS PRE- AND POST-PPS ADJUSTED FOR SICKNESS AT ADMISSION, BY DISEASE

		CHF		AMI		PNE		CVA		HIP		5 Diseases	
Adjusted Outcome[a]	Days after Admission	Pre n=1,078	Post n=1,247	Pre n=1,055	Post n=1,144	Pre n=960	Post n=1,123	Pre n=1,164	Post n=1,273	Pre n=985	Post n=1,045	Pre n=5,242	Post n=5,832
Percentage of patients with death or readmission within 180 days[b]	180	68	65	60	64*	52	50	63	63	42	39	57	56
Percentage of patients with readmission within one year[c]	365	69	65*	56	60	52	48	57	57	48	42*	56	54
Mean number of inhospital days within one year[d]	365	18	13*	11	11	12	9*	14	13	11	8*	13	11*

NOTE: * $p < 0.05$ for comparison of outcomes pre- and post-PPS.

[a] Outcomes are adjusted for sickness at admission using scales designed to predict death at 30 and 180 days postadmission.

[b] Death (inhospital or postdischarge) or any readmission within 180 days after admission.

[c] Any readmission within one year of admission among patients discharged alive from the initial hospitalization.

[d] Mean number of inhospital days within 365 days after the initial hospitalization for all sampled patients discharged alive regardless of readmission.

Table 7.6

SUMMARY OF PERCENTAGE CHANGES IN OUTCOMES POST-PPS COMPARED WITH PRE-PPS

Outcome	CHF	AMI	PNE	CVA	HIP	5 Diseases
Inhospital mortality[a]	−3*	−2*	−3*	−5*	−2*	−3*
30-day postadmission mortality[a]	−2	0	0	−1	−1	−1*
180-day postadmission mortality[a]	−2	+1	+1	−1	−3	−1
Home patients not discharged to home[b]	+2	+4*	+4*	+2	+8*	+4*
Prolonged nursing home stay[c]	0	+1	+2	+2	+1	+1
180-day postadmission mortality or readmission[a,d]	−3	+4*	−2	0	−3	−1
365-day postadmission readmission[a,e]	−4*	+4	−4	−0	−6*	−2

NOTE: * $p < 0.05$.

[a] Adjusted for sickness at admission.

[b] Includes only patients admitted to hospital from home.

[c] Prolonged nursing home stay is measured by physician bill to a skilled nursing facility or other (residential) nursing home within five, six, and seven months postadmission for three states combined, but only for patients admitted to hospital from home and alive as of seven months postadmission.

[d] Death or readmission within 180 days postadmission among all sampled patients.

[e] Readmission within one year postadmission among all sampled patients.

DISCUSSION

Before discussing the relationship between the introduction of prospective payment and changes in medical outcomes, it is important to place these results in context by noting the severe burden of illness carried by elderly patients hospitalized with one of these five conditions. By 30-days posthospital admission, 16 percent of these patients have expired, with the death rate climbing to 29 percent within six months of admission. For the surgical condition—hip fracture—the six-month mortality rate is only 16 percent, but for the four medical conditions it is over 33 percent.

This burden of illness is also shown by readmissions. Of patients who survived the initial hospitalization, more than half were readmitted in the next year. This fraction is highest for patients initially hospitalized with congestive heart failure (66 percent) and lowest for hip fracture patients (44 percent).

In addition, 25 percent of patients admitted from home and discharged alive are discharged to an institution. Forty-one percent of cerebrovascular accident patients and 52 percent of hip fracture patients previously living at home are discharged to an institution. These patients have a higher risk of dying but of the patients still alive seven months after hospital admission only 6 percent are in a nursing home. Thus, most patients discharged to a nursing home are there for a relatively short stay.

Before and after the implementation of prospective payment, clinicians, patients, and families have feared, and in some instances have reported, disasters in outcomes of care that were thought to be related to the new financial incentives. We have measured outcomes pre- and post-PPS on a nationally representative database of more than 14,000 patients who were hospitalized with one of five diseases that make up 18 percent of Medicare admissions and 32 percent of deaths within 30 days. In spite of these fears and anecdotal reports, we find no significant changes for the worse in either mortality at 30 and 180 days posthospital admission on the one hand or readmission and prolonged nursing home stay on the other.

We did find a significant increase in the fraction of patients discharged directly to an institution, but this does not appear to have resulted in a significant increase in prolonged nursing home stay. Our results, based on data from about 150 hospitals in three states, are not consistent with Fitzgerald et al.'s findings (1987, 1988) of large increases in discharges to nursing homes and prolonged nursing home stays for hip fracture patients from one large hospital. Our findings are consistent, however, with the clinical study of Mayer-Oaks et al. (1988) examining outcomes of intensive care unit patients in three hospitals, the study of DesHarnais et al. (1988) using secondary datasets to analyze inpatient mortality, and the studies of Palmer et al. (1989) and Gerety et al. (1989) that examined outcomes for hip fracture patients.

The findings reported here do not prove that prospective payment is continuing not to have a negative impact on outcome. Because of the manner in which PPS was introduced, it was not possible to do a controlled trial of its effects, which would have permitted comparison of actual outcomes in the late 1980s under PPS with outcomes during the same time period in the absence of PPS. Valid causal conclusions from the only available data, which are observational in character, are difficult to achieve; we explore these issues in Secs. V and VIII.

Moreover, our post-PPS data came from 1985–1986, a period in which the financial bases for prospective payment were still changing. The rates paid to hospitals at that time still included a component based on historical charges during the cost-plus reimbursement era before PPS. In addition, the amount of reimbursement for a patient with a given diagnosis has been changing since 1986, and hospitals' financial margins have diminished. Further cuts in length of stay may be harder to achieve without negative impacts, and evidence from Sec. VI suggests that clinical instability at discharge has increased post-PPS. Last, although on average outcomes have not worsened, some groups of patients may have suffered. Analyses to address this last issue are ongoing.

In sum, these data suggest that prospective payment was implemented in a manner that did not adversely affect overall outcomes for hospitalized Medicare patients. However, the evidence also suggests that continuous clinical monitoring on a national level is indicated to insure that the continuing changes in prospective payment do not negatively affect the outcomes of care.

VIII. QUALITY OF CARE BEFORE AND AFTER PPS: A SUMMARY OF EFFECTS

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Our study had two purposes: to evaluate the quality of care given to the nation's Medicare patients in the pre- and post-PPS periods, and to compare observed post-PPS quality with predictions of what quality of care might have been in the post-PPS period, in the absence of the PPS intervention. In previous sections, we documented significant differences in sickness at admission, processes of care, instability at discharge, and outcomes for Medicare patients hospitalized before and after implementation of PPS. Specifically, we demonstrated that, during the post-PPS period, sickness at admission was higher, inhospital processes of care were better, instability at discharge was higher, and mortality both 30 days and 180 days following admission was lower or unchanged, when compared with the pre-PPS period. In this section we attempt to sort out which of these differences may have been caused by PPS and which by other factors that also changed during the same time period.

Many changes with the potential to affect the quality of hospital care in the United States have occurred over the past ten years in addition to PPS. The number of patients treated in outpatient settings has risen, and the average burden of illness of such patients has also increased. In a reaction against extending life in a futile state, the use of DNR orders has grown (Scheidermayer, 1988; and Bedell and Delbanco, 1984). PROs were established and have been extending their reach and insisting on better accountability. New technologies and medical knowledge have become available, and as time passes, older physicians are continually being replaced by younger physicians who have more thorough training in the use of the new methods.

We report in this section on three types of analyses we have conducted to supplement our previous descriptive before-after comparisons with judgments as to which of the observed changes were caused by PPS. First, we estimate the impact on mortality following hospitalization of each of the changes from pre- to post-PPS described above. Second, for factors where changes appear to be substantial, we examine patterns of change among patient subsets, to see whether the changes are consistent or concentrated in particular types of patients and hospitals. Third, we extend our before-after comparisons to a time series analysis with multiple time points pre- and post-PPS, examining trends within and across both periods to see if post-PPS values of important quality of care measures are consistent with pre-PPS trends.

METHODS

Estimating the Impact of Pre- and Post-PPS Changes on Mortality

In the first of our three methods for establishing which changes were likely to have been caused by PPS, we identified 22 variables, each of which by itself is associated with changes in mortality 30 and 180 days postadmission. Table 8.1 summarizes and defines these variables. The first five variables in Table 8.1 measure demographics: age, gender, Medicaid status, race, and admission from a nursing home. The next six variables directly or indirectly measure patient sickness at admission: preadmission functional status; two scales we developed to measure acute (generally correctable) and chronic (generally not correctable) illness at admission; two additional scales we created (Sec. VII) for predicting death within 30 and 180 days of admission from symptoms, signs, laboratory values, and diagnoses present at admission; and the presence of a DNR order on days 1 or 2 of the hospital stay. The next seven variables measure the processes of care given to the patient during the hospital stay: five scales we developed (Sec. IV) that measure physician cognitive diagnostic processes, nurse cognitive diagnostic processes, technical diagnostic processes, technical therapeutic processes, and use of telemetry or ICU monitoring; an overall scale summarizing these five component process scales; and the presence of a DNR order written on the third or later day of the hospitalization (considered as a process measure). The next three variables are scales we created (Sec. VI) measuring instability at discharge (i.e., generally correctable symptoms or signs that were not corrected), sickness at discharge (i.e., symptoms or signs of illness that were not necessarily correctable), and very abnormal last laboratory values obtained during the hospital stay. The last variable in Table 8.1 measures whether patients were discharged to home or to an institution (e.g., a skilled nursing facility) (Sec. VII).

We conducted two types of mortality analyses with these variables. In the first analysis, we measured the size of the changes from pre- to post-PPS in each variable, and used linear regression to estimate the change in both 30-day and 180-day mortality associated with a change of that magnitude. In the second analysis, we postulated a sequence of effects corresponding to the temporal order in which the variables potentially affect the patient before and during the hospital stay. In this temporal order, the five demographic variables came first (introduced simultaneously), followed by: our 180-day sickness-at-admission scale (the single admission sickness measure most highly correlated with long-term death); initial DNR status; our summary inhospital process measure; subsequent DNR status; and four discharge status variables: instability at discharge, abnormal last laboratory values, sickness at discharge, and discharge destination. We computed the expected change in 180-day mortality associated with the change in each variable, adjusting for all earlier variables in the temporal sequence. We provide details on the calculations leading to these estimates below. Note that these were comparative analyses, designed to tell us which factors were potentially the most influential on death, and that as such they are sufficient to demonstrate association but not necessarily causation. Note also that sequences of variables different from the ordering we chose would produce different effect estimates for the variables in our analysis (except for demographics, which were entered as a block of variables at the beginning of the sequence).

Methods for Estimating the Effects on Mortality of Changes in Variables from Pre- to Post-PPS. In the first part of our mortality audit, we took each variable listed in Table 8.1 through three steps. First we noted how the variable changed from pre- to post-PPS. Second, we used simple linear regression of mortality on each variable to assess the

Table 8.1

VARIABLES USED TO STUDY EFFECTS OF PPS ON MORTALITY FOLLOWING HOSPITALIZATION

Age: Age in years

Gender: Female (scored 1), male (scored 0)

Race: Black (scored 1), other (scored 0)

Medicaid: Had Medicaid (scored 1), all others (scored 0)

Preadmission nursing home residence: The patient resided in a nursing home immediately before the study hospitalization (scored 1), all others (scored 0). "Nursing home" is defined as a skilled nursing facility, intermediate care facility, extended care facility, or nursing home unspecified.

30-day mortality prediction: A disease-specific weighted sum of variables selected by logistic regression of 30-day postadmission death on clinical conditions present at the time of the study hospitalization. See Sec. III for details.

180-day mortality prediction: A disease-specific weighted sum of variables selected by logistic regression of 180-day postadmission death on clinical conditions present before admission for the study hospitalization. See Sec. III for details.

Initial DNR: A DNR order was written by the physician on days 1 or 2 of the study hospitalization (scored 1), all others (scored 0).

Process: Five standardized process scales summarizing disease-specific process measures including physician cognitive diagnostic processes, nurse cognitive diagnostic processes, technical diagnostic processes, technical therapeutic processes, and ICU/telemetry monitoring, plus an overall summary scale. See Sec. IV for details.

Subsequent DNR: A DNR order was written by the physician on day 3 or later of the study hospitalization (scored 1), all others (scored 0).

Instability at discharge: Scored 1 if there was at least one clinical problem noted at discharge (a) that should have been corrected before discharge and (b) that was likely to be associated with worse patient outcomes, all others (scored 0). See Sec. VI for details.

Abnormal last labs: Scored 1 if there was at least one dangerously abnormal laboratory value the last time laboratory values were recorded during the study hospitalization, all others (scored 0). See Sec. VI for details.

Sickness at discharge: Scored 1 if there was at least one measure of clinical sickness at the time of hospital discharge that included, but was not limited to, problems that should have been corrected before discharge, all others (scored 0). See Sec. VI for details.

Discharge destination: The patient's discharge destination was scored 1 if the patient was discharged to an institution, defined to include nursing homes (skilled, intermediate, extended care facilities, or unspecified); retirement homes (sheltered housing, congregate housing, halfway house, or board and care facilities); psychiatric facilities (mental hospitals); chronic disease hospitals; or rehabilitation hospitals; all others (scored 0). See Sec. VII for details.

NOTE: All variables were abstracted from the medical record.

effect of the variable on death rates 30 and 180 days after admission. Third, we put these two steps together multiplicatively to estimate the expected contribution of pre- and post-PPS changes in each variable to death rates, unadjusted for any other variables. For example, for congestive heart failure we found that the summary processs score was 0.42 standard deviation units higher post-PPS than pre-PPS. An increase of 1 standard deviation unit in this measure was associated with a 4.4 percentage point reduction in 30-day postadmission mortality for congestive heart failure patients. Thus we estimate the expected effect of the pre- and post-PPS change in process on 30-day mortality for congestive heart failure patients, if nothing else had changed, to be a mortality reduction of 0.42 × 4.4 = 1.8 percentage points. This analytic method has been described in more detail by Wonnacott and Wonnacott (1984).

In the second part of the mortality audit, we postulated a sequence of effects corresponding to the temporal order in which factors potentially affect the patient arriving at the hospital. We began with a dummy variable for pre- and post-PPS and then added to the model demographics, sickness at admission, initial DNR, process, subsequent DNR, and discharge variable (instability at discharge, sickness at discharge, very abnormal last laboratory values, and discharge to a nursing home). It is important to note that, with this approach, attributions of the effect of pre- and post-PPS changes on mortality will depend upon the sequencing of factors. Changing the order of demographics and sickness at admission, for example, would change the perception of which of these two is responsible for changes in death resulting from sickness at admission but would not affect other conclusions.

To evaluate the effects of demographics, sickness at admission, and inhospital processes of care, we used linear regression models. Standard errors for effect estimates were determined by propagation of error (Yasukawa, 1930). For example, the coefficient of process for congestive heart failure in our linear regression of 30-day mortality on demographics, sickness at admission, initial DNR, and process was –0.024 with a standard error of 0.008, and the pre- post-PPS improvement in process (adjusting for the variables before process in the temporal sequence) was 0.43 with a standard error of 0.036. Thus the estimated adjusted effect of the pre- post-PPS change in process on 30-day mortality was (–0.024 × 0.43) = –1.0 percentage points, and the standard error of this estimate was [(0.036 × 0.024) × 2 + (0.008 × 0.43) × 2] = 0.37 percent.

To assess the impact of the discharge status variables on postdischarge mortality, we used Cox proportional hazards time-varying regression (Kalbfleisch and Prentice, 1980). This model predicts patient mortality on each day after admission as a function of all of the admission variables. A time-varying dummy variable is used to account for the different mortality rates of patients inside and outside the hospital. Discharge variables are introduced as of the date of discharge. This method accounts for the decrease in length of stay associated with the introduction of PPS and the decrease in mortality as a function of time after admission, up to at least 60 days. The Cox model gives the relative probability of death for each variable. To get its actual impact, we multiplied this effect by the average probability of death between discharge and 180 days.

Patient and Hospital Subset Analysis Methods. We used regression to see whether the changes from pre- to post-PPS in our summary process measure, initial DNR use, and instability at discharge were significantly different for subgroups of patients defined by hospital- and patient-level grouping variables. For example, to assess the significance of the effect on process of the categorical city size/teaching variable described in Methods, above, with levels of rural nonteaching, urban nonteaching, and urban teaching, we linearly regressed process on a dummy variable for pre- post-PPS, our 30-day sickness-at-admission scale, a set of two dummy variables defining city size/teaching status, and a set of two dummy variables representing the interaction between pre- post-PPS and city size/teaching. The adjustment for sickness at admission had little effect, so we report unadjusted means in Table 8.3, below. Logistic regression was used instead of linear regression for initial DNR status and the presence or absence of one or more instabilities at discharge.

Trend Analysis Methods. We used simple time series methods to investigate whether post-PPS values of 30-day mortality (adjusted for sickness at admission), overall inhospital process, instability at discharge, and initial use of DNR orders were reasonably consistent with pre-PPS trends. To do this, we calculated quarterly means, aggregating across the five diseases, of each of these measures and made time series plots of the mean values, with traces two standard errors either way from the means superimposed to illustrate the sampling variability. We then explored a variety of simple models extrapolating the pre-PPS trends to the post-PPS period and fitting the observed post-PPS trends, including constant, linear, and quadratic time effects. Constant and linear trends were sufficient to describe the behaviors observed in Figs. 8.1–8.4, below. For at least two reasons—our data go back only to 1981, and there is substantial forecasting uncertainty internal to a single extrapolation model, as well as uncertainty about the form that such a model should take—it should not be concluded that these methods are sufficient to definitively estimate what quality of care would have been like in the post-PPS period in the absence of PPS. Nor are they intended to: They serve only to help confirm or deny PPS's role in causing the observed differences.

In the analysis of the sources of change, we also tested interactions between the variables in this analysis and those in pre- and post-PPS periods. If present, these interactions would signify changes in the relationship between these factors and death. An F-test was used.

Patient and Hospital Subset Analyses

With our second method, we examined patient and hospital subsets to see whether pre- and post-PPS differences occurred globally across all subsets or were restricted to certain patient groups. Underlying this analysis was the idea that a large systemic change, such as Medicare's movement from retrospective to prospective payment, is likely to have had pervasive effects that appear consistently across a wide variety of patient and hospital types. Less global changes, such as diffusion of current standards of medical practice from urban to rural hospitals, that took place at about the same time as the introduction of PPS might have had isolated effects that were concentrated in certain classes of patients and hospitals.

In this analysis, we examined how process, initial DNR use, and discharge status changed across patient subsets defined by a variety of patient- and hospital-level factors. The patient subsets we studied differed by levels of sickness and functioning, and the hospital subsets by city size, state, percentage of Medicaid patients, and teaching status. We computed separately for each of our five diseases the changes from pre- to post-PPS in initial use of DNR orders, our overall process of care scale, and instability at discharge for each subset of the city size/teaching variable, separately for each of the five diseases, and used linear regression to assess the significance of these differences (see above). Next, we developed a hospital-level variable that combined city size and teaching as follows: (1) rural nonteaching, (2) urban nonteaching, and (3) urban teaching, because these were the most interesting distinctions. (The category, rural teaching, had virtually no hospitals.)

We used linear regression to assess the significance of differences in process, initial DNR use, and discharge status for patients in these three subsets.

Trend Analyses

Finally, we made graphical comparisons between (a) the actual values of important quality of care variables in 1985–1986 and (b) simple estimates of what those values might have been if PPS had not been implemented. To do this we used our patient-level data to calculate quarterly summaries of four variables: 180-day mortality, adjusted for sickness at admission; overall inhospital process; instability at discharge; and initial use of DNR orders. We plotted these quarterly values on the same graphs with predictions based on simple extrapolations from the pre-PPS period (see above). With only eight quarters of data in the pre-PPS period and with PPS introduced nonexperimentally, our ability to definitively say what quality of care would have been like in the post-PPS period in the absence of PPS is limited (for example, the confidence bands based on linear extrapolation models are quite wide). However, if changes between 1981–1982 and 1985–1986 are consistent with trends within those two time periods, it would appear that the changes are a continuation of trends in place historically and not a specific result of PPS.

RESULTS

The Analysis of the Sources of Change

Table 8.2 shows how each variable in Table 8.1 changed from the pre-PPS to the post-PPS period, and how these differences are associated with changes in mortality rates 30 and 180 days after admission. Each row in Table 8.2 has four values: the pre-PPS mean of the variable defining that row, the mean change in that variable from pre- to post-PPS, and the expected changes in mortality 30 and 180 days from admission associated with that variable's pre- and post-PPS difference. This table displays the independent effect on mortality of the pre- and post-PPS difference in each measure, unadjusted for any other variables. For example, Table 8.2 shows that the average age of congestive heart failure patients increased, but not significantly, from 78.3 years pre-PPS to 78.3 + 0.3 = 78.6 years post-PPS. Given the relationship between age and mortality, this increase in age translates, without adjusting for any other variables, into an 0.1 percentage point expected increase in both 30-day and 180-day postadmission mortality.

Among the demographic variables, age increased post-PPS for the four medical diseases ($p < 0.05$ for acute myocardial infarction patients) but stayed about the same for hip fracture patients. Preadmission residence in a nursing home also increased for patients with the four medical diseases ($p < 0.05$ for two of the four medical conditions) but decreased significantly for patients with hip fracture ($p < 0.05$).

The six sickness variables show that patients were noticeably sicker at admission in 1985–1986 than in 1981–1982 (especially pneumonia patients), a difference that is associated with higher mortality rates post-PPS. Three of these measures—acute sickness, chronic sickness, and functional status—are uncorrected for changes in recording and laboratory ordering between the pre- and post-PPS periods. When we adjust for these changes and use recording-insensitive criteria (such as our 30-day and 180-day sickness scales), we still find that patients are sicker post-PPS, but the differences are less pronounced (Sec. III). We also

Table 8.2

CHANGES IN 22 VARIABLES PRE- AND POST-PPS AND EXPECTED DIFFERENCES IN MORTALITY PER 100 PATIENTS ASSOCIATED WITH THESE CHANGES

Measures	Pre-PPS Values (in Original Units)	Differences (Post-PPS – Pre-PPS)	Expected Change from Pre- and Post-PPS Changes in Variables[a]	
			30-Day Mortality[b]	180-Day Mortality[b]
Congestive Heart Failure				
Age (years)	78.3	+0.3	0.1	0.1
Gender (% female)	57.1	–2.2	0.0	0.0
Medicaid patient (%)	17.9	–0.6	0.0	0.0
Black (%)	14.3	–1.7	0.2	0.2
Preadmission nursing home (%)	8.9	+2.0	0.2	0.3
Function	1.6	+0.3*	0.2	0.5
Acute sickness	2.2	+0.3*	0.6	0.8
Chronic sickness	4.7	+0.4**	0.3	0.9
30-day sickness scale	32.3	+0.2	0.2	0.5
180-day sickness scale	38.3	+0.3	0.3	0.6
Initial DNR (%)	3.8	+1.7*	0.4	0.6
ICU/telemetry process	–0.13	+0.2*	–0.3	–1.2
Physician cognitive process	–0.16	+0.3**	–0.9	–1.2
Nurse cognitive process	–0.20	+0.4**	–1.4	–1.5
Technical diagnostic process	–0.06	+0.3**	–0.2	–0.2
Technical therapeutic process	–0.13	+0.1*	–0.5	–0.3
Overall process	–0.22	+0.4**	–1.8	–2.2
Subsequent DNR (%)	1.4	+0.5	0.0	0.2
Abnormal last lab (%)	22.9	–1.3	–0.0	–0.1
Instability at discharge (%)	7.3	+1.7*	0.1	0.2
Sickness at discharge (%)	21.8	+5.4**	0.2	0.6
Discharge to a nursing home (%)	6.9	+1.6*	0.1	0.3
Acute Myocardial Infarction				
Age (years)	75.4	+0.7*	0.6	0.9
Gender (% female)	47.0	+2.9	0.0	0.1
Medicaid patient (%)	13.6	+0.1	0.0	0.0
Black (%)	8.2	+0.6	–0.0	–0.0
Preadmission nursing home (%)	4.8	+2.8*	0.3	0.5
Function	0.4	+1.2**	0.5	0.9
Acute sickness	6.3	+0.8**	1.9	2.3
Chronic sickness	0.91	+0.3**	0.6	1.2
30-day sickness scale	25.1	+1.0	1.4	1.7
180-day sickness scale	39.2	+1.4	1.5	2.0
Initial DNR (%)	2.4	+0.3**	1.3	2.0
ICU/telemetry process	–0.03	+0.05	–0.1	–0.1
Physician cognitive process	–0.15	+0.23 **	–1.7	–1.5
Nurse cognitive process	–0.12	+0.20 **	–1.4	–1.5
Technical diagnostic process	–0.09	+0.17 **	0.2	0.4
Technical therapeutic process	–0.12	+0.20 **	–1.2	–1.0
Overall process	–0.14	+0.26 **	–1.9	–1.7
Subsequent DNR (%)	0.6	+1.4**	0.0	0.3
Abnormal last lab (%)	5.6	0.0	–0.0	–0.0
Instability at discharge (%)	4.2	+1.3	–0.0	0.0
Sickness at discharge (%)	13.3	+3.4*	0.1	0.3
Discharge to a nursing home (%)	3.7	+1.1	0.0	0.2
Pneumonia				
Age (years)	78.4	+0.4	0.3	0.5
Gender (% female)	49.2	+0.3	–0.0	–0.0
Medicaid (%)	21.4	–0.1	–0.0	–0.0
Black (%)	8.0	+1.5	0.0	0.1
Preadmission nursing home (%)	24.5	+4.3	0.7	1.1

Table 8.2—continued

Measures	Pre-PPS Values (in Original Units)	Differences (Post-PPS – Pre-PPS)	Expected Change from Pre- and Post-PPS Changes in Variables[a]	
			30-Day Mortality[b]	180-Day Mortality[b]
Function	1.7	+0.4**	1.5	2.6
Acute sickness	8.2	+0.8**	1.9	2.5
Chronic sickness	4.2	+1.0**	1.7	3.3
30-day sickness scale	25.8	+2.6**	3.4	4.7
180-day sickness scale	31.7	+3.4**	3.6	5.4
Initial DNR (%)	7.1	+3.9**	1.3	2.0
ICU/telemetry process	–0.12	+0.12*	0.6	0.5
Physician cognitive process	–0.13	+0.24**	–0.5	–0.5
Nurse cognitive process	–0.20	+0.38**	–2.0	–3.1
Technical diagnostic process	–0.07	+0.14**	–0.3	–0.4
Technical therapeutic process	–0.11	+0.22**	–0.4	–0.6
Overall process	–0.22	+0.42**	–1.2	–2.1
Subsequent DNR (%)	1.9	+1.5**	0.1	0.3
Abnormal last lab (%)	13.7	+2.6*	0.1	0.2
Instability at discharge (%)	6.7	+1.7*	0.0	0.2
Sickness at discharge (%)	24.6	+12.1**	0.4	0.9
Discharge to a nursing home (%)	11.6	+4.2**	0.3	0.9
Cerebrovascular Accident				
Age (years)	78.3	+0.1	0.1	0.2
Gender (% female)	54.6	+2.0	0.0	0.1
Medicaid patient (%)	16.5	–2.0	–0.1	–0.1
Black (%)	11.7	+0.1	–0.0	0.0
Preadmission nursing home (%)	14.1	+0.4	0.1	0.1
Function	1.2	+0.0	0.2	0.3
Acute sickness	5.3	+0.2	1.1	1.4
Chronic sickness	3.6	+0.4**	0.2	0.6
30-day sickness scale	20.2	–0.5	–0.8	–0.9
180-day sickness scale	29.7	–0.6	–0.9	–1.2
Initial DNR (%)	7.1	+3.9**	1.3	2.0
ICU/telemetry process	–0.07	+0.08	0.2	0.2
Physician cognitive process	–0.20	+0.37**	–0.7	–0.6
Nurse cognitive process	–0.25	+0.47**	–0.9	–1.1
Technical diagnostic process	–0.13	+0.26**	–0.6	–0.5
Overall process	–0.25	+0.49**	–1.1	–1.2
Subsequent DNR (%)	4.2	+0.7	0.0	0.1
Abnormal last lab (%)	11.5	–0.5**	–0.0	–0.1
Instability at discharge (%)	10.0	+2.0*	0.1	0.2
Sickness at discharge (%)	12.2	+2.7*	0.1	0.5
Discharge to a nursing home (%)	21.4	+2.6*	0.1	0.6
Hip Fracture				
Age (years)	81.5	–0.1	–0.0	–0.1
Gender (% female)	79.0	–2.7	0.1	0.3
Medicaid patient (%)	17.7	–0.6	–0.0	–0.0
Black (%)	5.6	0.0	0.0	0.0
Preadmission nursing home (%)	28.4	–3.8*	–0.1	–0.4
Function	2.2	0.0	–0.0	–0.1
Acute sickness	1.0	0.0	0.0	0.0
Chronic sickness	3.0	+0.4**	0.4	1.0
30-day sickness scale	7.2	+0.4**	0.2	0.6
180-day sickness scale	14.6	+0.7	0.3	0.9
Initial DNR (%)	0.4	+0.8*	0.1	0.2

Table 8.2—continued

Measures	Pre-PPS Values (in Original Units)	Differences (Post-PPS - Pre-PPS)	Expected Change from Pre- and Post-PPS Changes in Variables[a]	
			30-Day Mortality[b]	180-Day Mortality[b]
ICU/telemetry process	–0.00	0.00	0.0	0.0
Physician cognitive process	–0.09	+0.17**	0.1	0.1
Nurse cognitive process	–0.16	+0.31**	–0.1	–0.4
Technical diagnostic process	–0.24	+0.29**	–0.1	–0.2
Technical therapeutic process	–0.13	+0.23**	0.1	–0.2
Overall process	–0.22	+0.42**	0.2	–0.1
Subsequent DNR (%)	2.1	–0.1	–0.0	–0.0
Abnormal last lab (%)	14.6	+0.4	0.0	0.0
Instability at discharge (%)	9.5	+2.0*	0.0	0.1
Sickness at discharge (%)	14.8	+1.8	0.0	0.2
Discharge to a nursing home (%)	29.6	+1.9	0.0	0.3

NOTE: *$p < 0.05$, **$p < 0.01$.

[a] Expected change in mortality from post-PPS changes in admission variables is computed by multiplying the change in the measure from pre-PPS to post-PPS by the regression coefficient of the measure for predicting death (see above). These effects are unadjusted for changes in any other measures.

Expected change in mortality from post-PPS changes in discharge variables (subsequent DNR, instability, abnormal last lab, sickness at discharge, discharge to a nursing home) is computed by multiplying the change in the measure from pre-PPS to post-PPS (excluding inhospital deaths and acute care transfers) by the hazard ratio from a proportional hazards model by the probability of death between discharge and 30 or 180 days (see above).

[b] A minus sign means that predicted mortality was lower post-PPS as a result of the change in the variable defining a given row; a plus sign means that predicted mortality was higher post-PPS.

found significant increases in the initial use of DNR orders in all five study diseases (from 7.1 percent to 11.0 percent in pneumonia, for example). Unadjusted for other variables, this increase in the frequency with which DNR orders are written is associated with a substantial increase in mortality.

The five process scales and the overall summary process measures show dramatic and significant improvements during the post-PPS period for all diseases ($p < 0.01$). These improvements are associated with a large decline in mortality. The frequency of DNR orders written on day 3 or later increased post-PPS (significantly for acute myocardial infarction and pneumonia, $p < 0.01$), but such orders remain rare. Sickness at discharge increased post-PPS, significantly for all diseases except hip fracture; the increase was particularly large for pneumonia patients (pre-PPS 24.6 percent of pneumonia patients had at least one sickness indicator present at discharge, compared with 36.7 percent post-PPS). Instability at discharge also increased significantly for all diseases except myocardial infarction. These changes are associated with higher mortality post-PPS.

Table 8.3 presents data similar to those given in Table 8.2 for the effects of changes in summary variables from Table 8.2 on 180-day postadmission mortality. However, in Table 8.3 the estimates were adjusted for prior variables in the temporal sequence, whereas in Table 8.2 the estimates were unadjusted. For example, in Table 8.3, the effect of changes in process on mortality takes account of the effects of changes in demographics, sickness at admission, and initial use of DNR orders on mortality. The effects on 30-day mortality are very similar, so they are not shown.

Table 8.3

SUMMARY OF PREDICTED CHANGES IN 180-DAY POSTADMISSION MORTALITY PER 100 PATIENTS FROM CHANGES PRE- TO POST-PPS IN 14 VARIABLES

	CHF	AMI	PNE	CVA	HIP
Patient Demographics[a]	0.7**	1.2**	1.4**	0.3	-0.2
Age	0.1	0.8**	0.3	0.2	-0.1
Gender (female)	0.2	0.0	0.0	0.0	0.3
Race (black)	0.1	-0.0	0.1	0.0	0.0
Medicaid	0.0	0.0	0.0	0.0	0.0
Preadmission residence	0.3	0.4*	1.0**	0.1	-0.4*
Sickness at admission[b]	-0.1	0.5	3.0**	-1.1	1.1**
Initial DNR	0.3	0.7**	0.5*	0.5*	0.2
Process	-1.0**	-0.7**	-1.3**	-1.0*	-0.5
Subsequent DNR	0.2	0.1	0.2	0.0	-0.0
Discharge problems[c]	0.6**	0.2	0.9**	0.6**	0.4
Instability at discharge	0.2	0.0	0.2	0.5*	0.1*
Abnormal last lab	-0.2	-0.0	0.2*	-0.1	0.0
Sickness at discharge	0.4*	0.2	0.3	0.1	-0.0
Discharge destination	0.2	-0.0	0.2*	0.1	0.3*
Total change accounted for[d]	0.7	2.0	4.7	-0.7	1.0
Actual differences in observed death rates (per 100 patients)[e]	-1.1	3.4	5.8	-1.2	-1.9
Remaining unexplained differences	-1.9	1.4	1.1	-0.6	-3.0

NOTES: * $p < 0.05$, ** $p < 0.01$. Except for demographics, the effect of each variable is the added effect, controlling for variables higher on the list. The mortality effects displayed here are an average of the pre-PPS period, in which mortality effects were large, and the post-PPS period, where they were somewhat smaller.

[a] Predicted changes for patient demographics are a sum of the predicted changes for age, gender, race, Medicaid, and preadmission residence.

[b] Sickness at admission is evaluated using two variables: scale designed to predict death at 30 days and a scale designed to predict death at 180 days (Table 8.1).

[c] Predicted changes for discharge problems are a sum of the predicted changes for instability at discharge, abnormal last laboratory value, sickness at discharge, and discharge destination.

[d] This row describes the total change post-PPS - pre-PPS in 180-day post-admission mortality rates that are accounted for by the post-PPS - pre-PPS changes in the 13 variables listed above. For example, for CHF, the sum of the percentages listed above is 0.8 percent, meaning that mortality associated with the named factors is estimated to increase by a total of 0.8 percentage points. The actual observed change in death rates is −1.1 percent and the difference (−1.1−0.8) is due to other unnamed causes.

[e] Actual differences in observed death rates when comparing 180-day unadjusted postadmission mortality rates post-PPS with pre-PPS: CHF 33.0 percent pre-PPS, 31.9 percent post-PPS; AMI 32.4 percent pre, 35.9 percent post; PNE 25.6 percent pre, 31.3 percent post; CVA 35.4 percent pre, 34.2 percent post; HIP 17.2 percent pre, 15.3 percent post.

The major effects on 180-day mortality associated with pre- and post-PPS changes in the variables in Table 8.3 are concentrated in four variables: sickness at admission, initial DNR, inhospital process of care, and discharge status. Post-PPS increases in admission sickness, adjusting for changes in demographics, had an especially pronounced predicted effect in pneumonia (an expected rise of 3.0 percentage points in 180-day mortality) and hip fracture. After adjusting for demographics and admission sickness, the post-PPS rise in the initial use of DNR orders was associated with a modest increase (0.2–0.7 percentage points) in expected mortality for all five diseases.

Improvements in inhospital process of care post-PPS (after accounting for changes in demographics, sickness at admission, and initial DNR orders) were associated with noticeable decreases in expected mortality for all five diseases (0.5–1.3 percentage points). These changes were significant for all conditions but hip fracture. There was a statistically significant rise in expected mortality associated with adverse changes in one or more discharge variables in four of the five diseases. Potentially remediable changes in discharge instability and abnormal last laboratory values were significant for three of the five diseases. Taken together, discharge problems post-PPS have increased enough to raise expected death rates by an amount that varies from a total of 0.2 percentage points for acute myocardial infarction patients to 0.9 percentage points for pneumonia patients.

Generally, interactions between the variables in Table 8.3 and time period were statistically insignificant. But for instability, the mortality differential associated with unstable discharge in 1985–1986 was only about 60 percent as large as it was in 1981–1982. This interaction effect was insignificant for individual diseases but significant ($p < 0.05$) when combined across all five diseases. Two hypotheses come to mind. First, this could be a real change in the effect of disability over time. Second, this could have reflected a change in the definition or use of instability measures. However, one must consider the second hypothesis in light of the finding that recording-sensitive symptoms and recording-insensitive vital signs both increased post-PPS (Sec. VI).

In Table 8.3, we present the actual changes in raw death rates, the total of all accounted-for expected changes, and the difference between these two figures. It is evident that this analysis explains only a portion of the actual differences. The discrepancies could be due either to sampling variability (the standard errors for the pre- and post-PPS changes in raw death rates are about 2 percentage points for each disease) or to systematic effects unaccounted for in our analysis of the sources of change. For example, our analysis does not address the contribution of new technology to lower death rates, because we specifically excluded new technologies from our process measures.

Patient and Hospital Subset Analyses

Table 8.4 presents differences (post-PPS minus pre-PPS) in our summary overall inhospital process score (in standard deviation units), the percentages of patients with a DNR order on admission, and the percentages of patients with one or more instabilities at discharge, for each of the three levels of the city size/teaching hospital variable we created (rural nonteaching, urban nonteaching, and urban teaching). Across all five diseases, we observed a consistent and significant pattern of differences by hospital setting in post-PPS improvements in explicit process of care. Rural nonteaching hospitals showed the biggest gains in inhospital process of care and urban teaching facilities the least.

Table 8.4

DIFFERENCES (POST-PPS MINUS PRE-PPS) IN PROCESS, INITIAL DNR, AND INSTABILITY AT DISCHARGE, BY CITY SIZE AND TEACHING STATUS OF HOSPITAL

Characteristics	Rural Nonteaching	Urban Nonteaching	Urban Teaching	Statistical Significance
Congestive Heart Failure (n = 2,812)				
Sample sizes	644	1,182	986	—
Process (standard deviation units)	+0.73	+0.38	+0.27	$p < 0.01$
Initial DNR (percentage points)	+3.1	+0.0	+2.7	NS
Instability at discharge (percentage points)	+4.3	+3.5	+2.8	NS
Acute Myocardial Infarction (n = 2,841)				
Sample sizes	623	1,238	980	—
Process (standard deviation units)	+0.40	+0.28	+0.17	$p < 0.05$
Initial DNR (percentage points)	+3.7	+3.0	+2.4	NS
Instability at discharge (percentage points)	+1.7	+1.1	+4.7	NS
Pneumonia (n = 2,727)				
Sample sizes	600	1,169	958	—
Process (standard deviation units)	+0.56	+0.41	+0.39	NS
Initial DNR (percentage points)	+3.5	+4.4	+3.5	NS
Instability at discharge (percentage points)	+11.6	−0.3	+2.5	$p < 0.10$
Cerebrovascular Accident (n = 2,810)				
Sample sizes	601	1,212	997	—
Process (standard deviation units)	+0.65	+0.49	+0.39	$p < 0.05$
Initial DNR (percentage points)	+1.4	+1.9	+4.0	NS
Instability at discharge (percentage points)	+6.3	+3.7	+2.3	NS
Hip Fracture (n = 2,746)				
Sample sizes	468	1,282	996	—
Process (standard deviation units)	+0.58	+0.43	+0.33	$p < 0.01$
Initial DNR (percentage points)	−0.4	+0.91	+1.4	NS
Instability at discharge (percentage points)	+11.31	+3.1	+2.9	$p < 0.10$

NOTES: Table entries give the "raw" differences (post-PPS minus pre-PPS) in the indicated variables (adjustment for sickness at admission had little effect). NS = not significant at the 10 percent level.

In contrast, initial use of DNR and instability at discharge showed consistent increases post-PPS across the three hospital types (Table 8.4). In analyses not reported here, we did find some differences in the magnitude of the pre-PPS minus post-PPS increase in DNR status as a function of patient characteristics, with the biggest rise post-PPS concentrated in patients with poor function and high levels of acute sickness at admission. Using the variables mentioned in Methods, above, to define subgroups, we were not able to find any types of patients for any of the five study diseases for whom the rise in discharge instability post-PPS differed significantly from the average increase in instability for all patients with that disease.

Trend Analyses

Figure 8.1 shows that the quality of inhospital process of care was on the rise before the introduction of PPS ($p < 0.01$) and continued to rise post-PPS, although at a slightly slower rate (the difference between the rates is not significant). Fig. 8.2 shows that use of initial DNR orders was increasing in 1981–1982 ($p < 0.05$) and that this increase continued in 1985–1986. The percentage of patients discharged with instability was reasonably flat both in 1981–1982 and in 1985–1986, with a jump between these two periods (Fig. 8.3). Sickness at discharge and discharge to a nursing home also had jumps between these time periods (not shown). Figure 8.4 presents quarterly values of 180-day mortality aggregated across the five diseases, after adjusting for sickness at admission. There was no trend in either period, and the post-PPS adjusted mortality values were consistent with the pre-PPS values.

DISCUSSION

After adjusting for sickness at admission, mortality was unchanged or lower in 1985–1986 after the introduction of PPS than in 1981–1982 before PPS was implemented. We believe that this was the result of two counterbalancing forces: sharp improvements in inhospital process from 1981 to 1986 that acted to lower mortality rates, offset by increases during the same period in sickness at admission, the use of DNR orders, and instability at discharge that acted to raise mortality. However, most of the process improvements we have documented were probably not caused by PPS. Two types of evidence presented here support

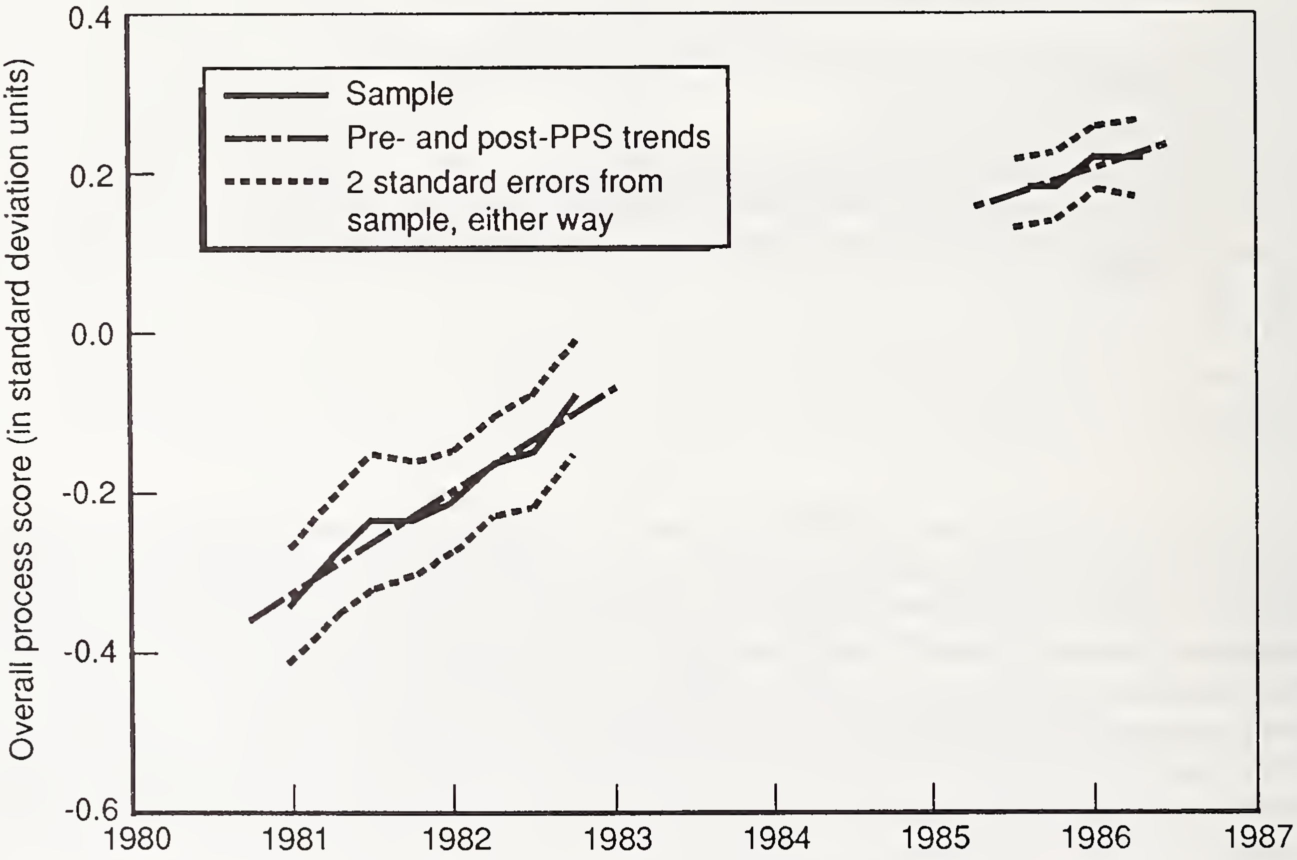

Fig. 8.1—Inhospital process trend (five diseases, n = 14,012)

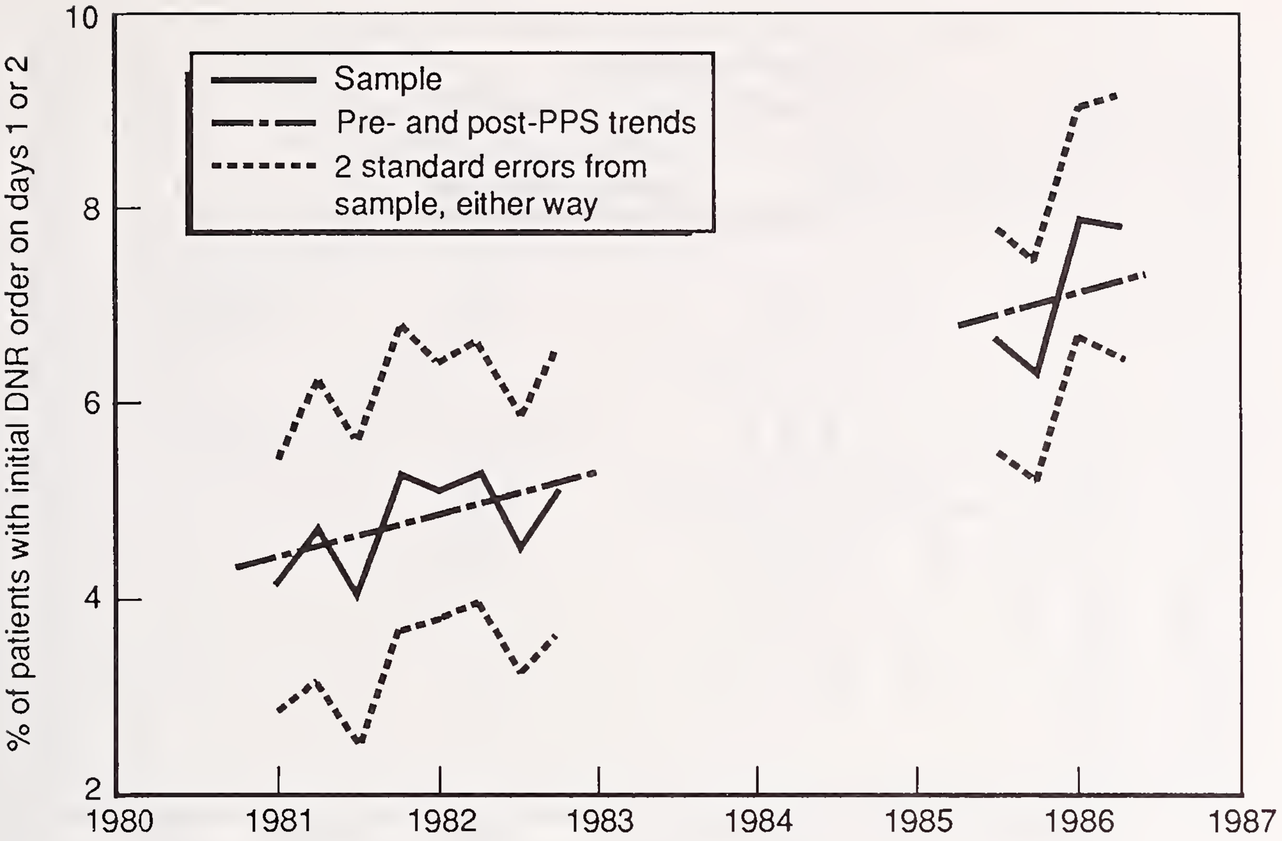

Fig. 8.2—Initial DNR trend (five diseases, n = 14,012)

this conclusion: the presence of a significant upward trend in process in the pre-PPS 1981–1982 period, and the lack of uniformity of the pre- and post-PPS improvements in process across different types of patients and hospitals. It is difficult to understand why, if PPS caused the gains in process we have demonstrated, it did so with substantially more force in rural nonteaching facilities than in urban teaching hospitals. Rather, it seems more plausible that ongoing trends in medicine, such as diffusion of newer methods into outlying areas, were responsible for the observed improvement. On this score PPS may be judged a success: Process did not deteriorate in the effort to save money.

An increased rate of DNR orders at admission post-PPS was associated with somewhat higher death rates. DNR orders potentially save the hospital money and the patients pain, but increased use of them is associated with an increase in death rates. The patient subgroups in which the biggest changes in DNR use were concentrated—those who were both acutely ill and functioning poorly—suggest that the potential benefits of medical care are being examined more closely for these patients. This makes sense and does not implicate PPS.

Instability at discharge and related factors have risen in a way that is temporally associated with PPS. Furthermore, instability is increasing across the board rather than in any specific patient or hospital subgroup and has increased in ways that we believe are not due to changes in recording (Sec. VI). Both results implicate PPS. On the face of it, this is a problem that needs attention.

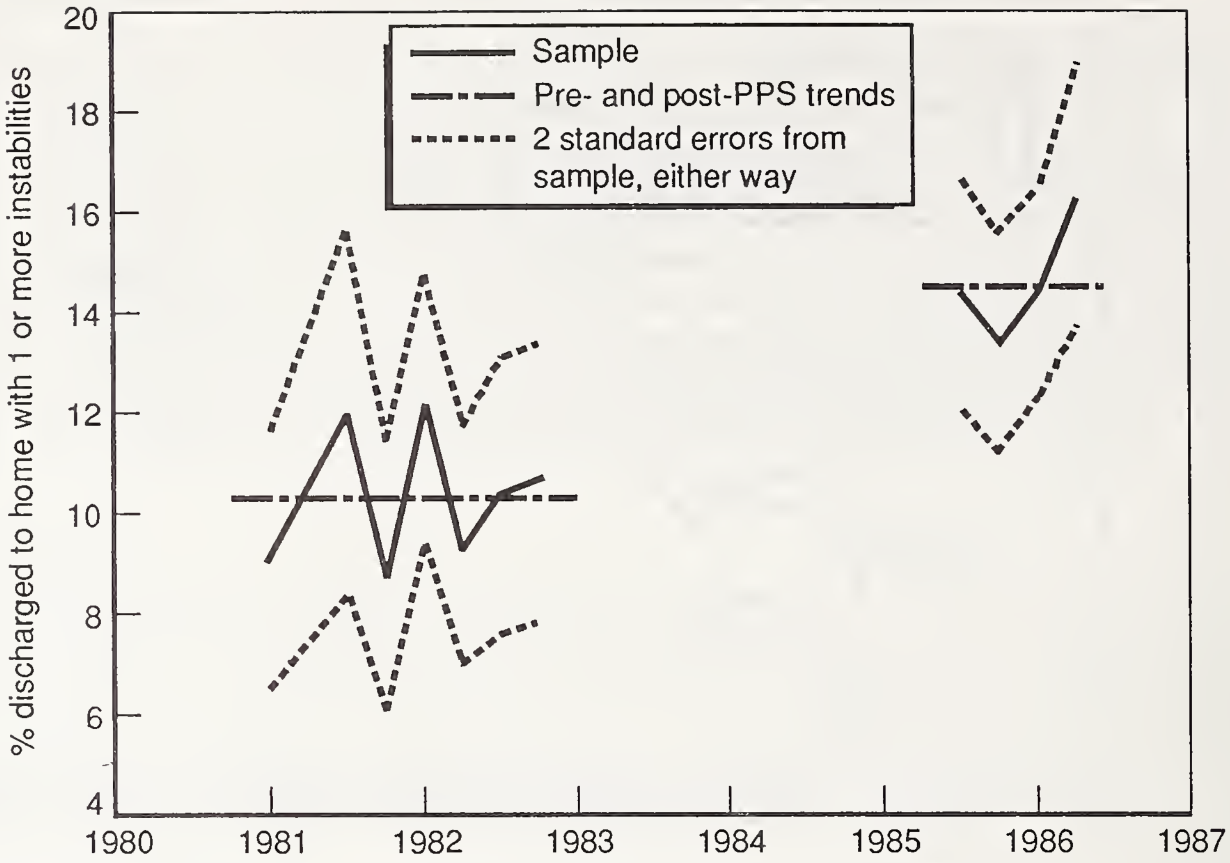

Fig. 8.3—Instability at discharge trend (five diseases, n = 7,412)

However, there is room for debate about how serious a problem this is. First, there is the issue of whether instability should be defined broadly or narrowly. If it is defined narrowly to include only factors that were clearly remediable, its increase post-PPS may be responsible for 0.5 percentage points of mortality increase, depending on disease. If it is defined broadly to include sickness at discharge and discharge to a nursing home, the associated rise in death rates may be as high as 0.9 percentage points. We do not know how fixable the latter group of problems are, but we do know that we measured only a fraction of problems that should be fixed before discharge.

Second, there is no guarantee that the hospital would be able to reduce mortality by holding unstable patients longer. Third, the effects of instability might be reduced by more cost-effective mechanisms other than increasing hospital length of stay. For example, unstable patients could be given special consideration in nursing homes or could be part of well designed posthospitalization home nursing programs. Indeed, the mortality impact of unstable discharge does not appear to be as great in 1985–1986 as it was in 1981–1982. Fourth, length of stay has remained relatively constant since 1986, so that any contribution of inappropriately short hospital stays to discharge problems has probably stabilized (Witsberger and Kominsky, 1990).

On the other hand, eliminating unstable discharges entirely (not just those evident post-PPS) might have a large impact on the effectiveness of hospital care. For the five diseases studied, unstable patients in the post-PPS period have a mortality rate 30 percent

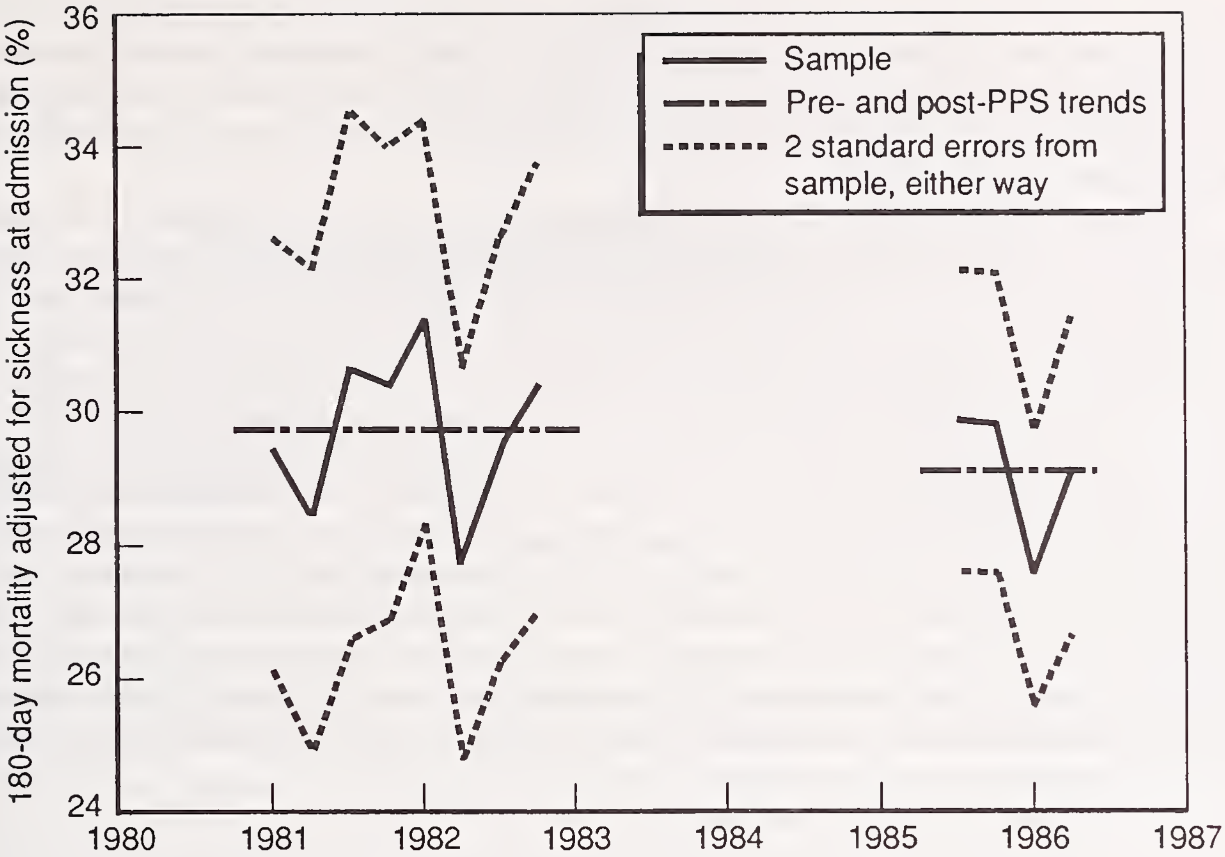

Fig. 8.4—Adjusted 180-day mortality trend (five diseases, n = 12,823)

higher than stable patients. This translates into 4.4 percentage points of additional mortality in the 90 days following admission for patients with discharge instability. An observational study such as ours cannot definitively estimate the effects of better discharge monitoring on patient outcomes; a controlled experiment with specific discharge protocols is required.

Between 1981–1982 and 1985–1986 there were also important changes in the demographics and sickness of patients. Pneumonia patients are much sicker at admission now than before. For other diseases, the nature of the change in admission sickness is less clear. As we mentioned in Sec. II, some of the apparent increase in sickness appears to be a recording bias. When we move from recording-sensitive sickness indicators (such as the functional status and acute and chronic sickness measures mentioned above and in Table 8.2) to the recording-insensitive indicators used in the remainder of this study's analyses (such as our 30-day and 180-day scales), the apparent rise in admission sickness is smaller. Another part of the rise in severity may be due to efforts by the PROs to restrict admissions of less sick patients. For two diseases (acute myocardial infarction and pneumonia) admissions of the least sick patients appear to be down about 30 percent.

In conclusion, because PPS was not introduced as an experiment, our observational time series study can provide only limited answers about the changes in quality of care that PPS, and PPS alone, caused. As we noted in Sec. VII three caveats are also worth bearing in mind when considering our results: (1) We studied only five diseases, albeit five important diseases in the Medicare cohort; (2) our study design allowed us to assess differences in quality of care only after patients had been hospitalized, so that, for example, we cannot comment on any changes in *access* to hospital care that PPS may have caused; and (3) our study covers the post-PPS era only through July 1986. Since that time hospital payments under PPS have been tightened (ProPac, 1988).

Even so, two key policy conclusions appear clear: (1) At least through the middle of 1986, PPS did not interrupt an important long-term trend toward better processes of inhospital care, a trend that has led to somewhat lower death rates; (2) on the other hand, we believe that PPS has had a notable effect on the stability with which patients are discharged. These conclusions lead to three major policy recommendations: (1) To eliminate any possible problems with patient instability at discharge, a more systematic assessment of the readiness of a patient to leave the hospital and be cared for as an outpatient or in an institution other than an acute care hospital should be made. Perhaps our instability-at-discharge scale would be a good place to start. (2) If further investigation suggests that some unstable discharges may be acceptable with suitable follow-up or could be prevented by longer hospital stays, we recommend that clinical trials be undertaken to evaluate the impact of such changes on mortality. (3) To provide current information about the effects of Medicare's payment methods on quality of care, we also recommend the continued collection of clinically detailed data that regularly monitor sickness at admission, processes of care, discharge status, and outcomes as long as prospective payment is in place.

Appendix A

FURTHER DETAILS ON DESIGN, SAMPLING, AND FIELDWORK

SAMPLING DISEASES

We selected a disease-specific model for measuring quality of care. We chose this approach because we believed it would allow us to collect more clinically meaningful data about patients for quality of care analyses.

We included only diseases that were generally stable diagnostically and therapeutically, had well-defined clinical criteria for making the diagnosis, and could be identified with reasonable certainty in both time periods using ICD-9-CM codes from 1981 to 1986.

We sampled patients with each of the six study diseases by ICD-9-CM codes. Table A.1 lists the six diseases by the ICD-9-CM code that we believed encompassed all possible definitions of the diseases and also lists the corresponding DRGs. Approximately 19 percent of Medicare hospital admissions and over 30 percent of 30-day mortality are for patients with one of these six diseases (HCFA, 1986a).

SAMPLING PATIENTS

Our goal was to sample roughly equal numbers of patients in each disease at each hospital. The national distribution of patients by disease per hospital makes this feasible without special adjustments for all the diseases we studied except depression, which presented unique challenges for the following reasons.

- Some hospitals have special psychiatric units in which patients with depression may be treated; some do not.
- Patients at a hospital with such a unit may be treated either in the psychiatric unit or in one of the scatterbeds in the rest of the hospital.
- In the post-PPS period, the psychiatric units in some hospitals are exempt from PPS; other such units fall under PPS reimbursement.

To have a chance to estimate the causal effect of these structural differences on quality of care, we had to adopt a somewhat complicated design that attempted to insure as much variation across these factors in the pre-PPS and post-PPS time periods as possible. Table A.2 summarizes the design goals we settled on, after examining MedPAR patient prevalence data to see what was feasible in the chosen states and areas. The entries in the table show the number of patients in each cell that would result in the desired sampling plan.

As a result of the structural factors just mentioned, the distribution of depression patients is highly irregular across short-term general care hospitals: none or very few at some facilities and a large number at others. For this reason, depression ended up driving the sampling plan to a larger extent than any of the other diseases. We attempted to insure that an adequate number of depression records would be available from each state by using patient prevalences

Table A.1

SIX DISEASES DEFINED BY ICD-9-CM CODES AND CATEGORIZED BY DRGS

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
Congestive Heart Failure				
HEART FAILURE & SHOCK	127	1.0164	428.0	Congestive Heart Failure
			428.1	Left Heart Failure
CIRCULATORY DISORDERS EXC AMI, W CARD CATH & COMPLEX DIAG	124	2.1680	428.0	Congestive Heart Failure
			428.1	Left Heart Failure
CIRCULATORY DISORDERS EXC AMI, W CARD CATH W/O COMPLEX DIAG	125	1.6069	428.0	Congestive Heart Failure
			428.1	Left Heart Failure
ACUTE MYOCARDIAL INFARCTION				
PERMANENT CARDIAC PACEMAKER IMPLANT WITH AMI OR CHF	115	3.8232	410.0	AMI Anterolateral Wall
			410.1	AMI Anterior Wall Nec
			410.2	AMI Inferolateral Wall
			410.3	AMI Inferoposterior Wall
			410.4	AMI Inferior Wall Nec
			410.5	AMI Lateral Wall Nec
			410.6	True Posterior Infarct
			410.7	Subendocardial Infarct
			410.8	Myocardial Infarct Nec
			410.9	Myocardial Infarct Nos
CIRCULATORY DISORDERS W AMI & C.V. COMP. DISCH. ALIVE	121	1.8211	410.0	AMI Anterolateral Wall
			410.1	AMI Anterior Wall Nec
			410.2	AMI Inferolateral Wall
			410.3	AMI Inferoposterior Wall
			410.4	AMI Inferior Wall Nec
			410.5	AMI Lateral Wall Nec
			410.6	True Posterior Infarct
			410.7	Subendocardial Infarct
			410.8	Myocardial Infarct Nec
			410.9	Myocardial Infarct Nos

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
CIRCULATORY DISORDERS W AMI W/O C.V. COMP. DISCH. ALIVE	122	1.3331	410.0	AMI Anterolateral Wall
			410.1	AMI Anterior Wall Nec
			410.2	AMI Inferolateral Wall
			410.3	AMI Inferoposterior Wall
			410.4	AMI Inferior Wall Nec
			410.5	AMI Lateral Wall Nec
			410.6	True Posterior Infarct
			410.7	Subendocardial Infarct
			410.8	Myocardial Infarct Nec
			410.9	Myocardial Infarct Nos
CIRCULATORY DISORDERS W AMI, EXPIRED	123	1.1094	410.0	AMI Anterolateral Wall
			410.1	AMI Anterior Wall Nec
			410.2	AMI Inferolateral Wall
			410.3	AMI Inferoposterior Wall
			410.4	AMI Inferior Wall Nec
			410.5	AMI Lateral Wall Nec
			410.6	True Posterior Infarct
			410.7	Subendocardial Infarct
			410.8	Myocardial Infarct Nec
			410.9	Myocardial Infarct Nos
	ACUTE MYOCARDIAL INFARCTION			
CARDIAC PACEMAKER REPLACE & REVIS EXC PULSE GEN REPL ONLY	117	1.7783	37.81	Replace Transven Electrod
			37.82	Replace Epicard Electrod
			37.83	Remove Transven Electrode
			37.84	Remove Epicard Electrode
			37.86	Remove Pacemaker System
			37.89	Revise Pacemaker Sys Nec
CARDIAC PACEMAKER PULSE GENERATOR REPLACEMENT ONLY	118	1.7392	37.85	Replace Pulse Generator
CARDIAC ARRHYTHMIA & CONDUCTION DISORDERS AGE <70 W/O CC	139	.8108	426.0	Atriovent Block Complete
			426.10	Atriovent Block Nos
			426.11	Atriovent Block-1st Degree
			426.12	Atriovent Block-Mobitz II
			426.13	Av Block-2nd Degree Nec
			426.2	Left BB Hemiblock
			426.3	Left BB Block Nec
			426.4	Rt Bundle Branch Block
			426.50	Bundle Branch Block Nos

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
			426.51	Rt BBB/Lft Post Fasc Blk
			426.52	Rt BBB/Lft Ant Fasc Blk
			426.53	Bilat BB Block Nec
			426.54	Trifascicular Block
			426.6	Other Heart Block
			426.89	Conduction Disorder Nec
			426.9	Conduction Disorder Nos
			427.81	Sinoatrial Node Dysfunct
			427.89	Cardiac Dysrhythmias Nec
			427.9	Cardiac Dysrhythmias Nos
			746.86	Congenital Heart Block
ACUTE MYOCARDIAL INFARCTION				
CARDIAC ARRHYTHMIA & CONDUCTION DISORDERS AGE >=70 &/OR CC	138	.9079	426.7	Anomalous A Excitation
			426.81	Lown-Ganong-Levine Synd
			427.0	Parox Atrial Tachycardia
			427.1	Parox Ventric Tachycardia
			427.2	Parox Tachycardia Nos
			427.31	Atrial Fibrillation
			427.32	Atrial Flutter
			427.41	Ventricular Fibrillation
			427.42	Ventricular Flutter
			427.60	Premature Beats Nos
			427.61	Atrial Premature Beats
			427.69	Premature Beats Nec
			785.0	Tachycardia Nos
			785.1	Palpitations
CARDIAC ARRHYTHMIA & CONDUCTION DISORDERS AGE <70 W/O CC	139	.8108	426.7	Anomalous A Excitation
			426.81	Lown-Ganong-Levine Synd
			427.0	Parox Atrial Tachycardia
			427.1	Parox Ventric Tachycardia
			427.2	Parox Tachycardia Nos
			427.31	Atrial Fibrillation
			427.32	Atrial Flutter
			427.41	Ventricular Fibrillation
			427.42	Ventricular Flutter
			427.60	Premature Beats Nos
			427.61	Atrial Premature Beats
			427.69	Premature Beats Nec
			785.0	Tachycardia Nos
			785.1	Palpitations

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
		HIP FRACTURE		
FRACTURES OF HIP & PELVIS	236	1.3530	820.00	Fx femur intrcaps nos-cl
			820.02	Fx femur midcervic-clos
			820.03	Fx base femoral nck-clos
			820.09	Fx femur intrcaps nec-cl
			820.20	Trochanteric fx nos-clos
			820.21	Intertrochanteric fx-cl
			820.80	Fx neck of femur nos-cl
		PNEUMONIA (PNE)		
RESPIRATORY INFECTION & INFLAMMATION AGE >=70 &/OR CC	79	1.7561	482.0	K. Pneumoniae Pneumonia
			482.1	Pseudomonal Pneumonia
			482.4	Staphylococcal Pneumonia
			484.8	Pneum in Infect Dis Nec
			507.0	Food/Vomit Pneumomitis
RESPIRATORY INFECTION & INFLAMMATION AGE 18-69 W/O CC	80	1.7036	482.0	K. Pneumoniae Pneumonia
			482.1	Pseudomonal Pneumonia
			482.4	Staphylococcal Pneumonia
			484.8	Pneum in Infect Dis Nec
			507.0	Food/Vomit Pneumomitis
SIMPLE PNEUMONIA & PLEURISY AGE >=70 &/OR CC	89	1.0771	480.9	Viral Pneumonia Nos
			481.	Pneumococcal Pneumonia
			482.2	H. Influenzae Pneumonia
			482.3	Stremtococcal Pneumonia
			482.8	Bacterial Pneumonia Nec
			482.9	Bacterial Pneumonia Nos
			483.	Pneumonia: Organism Nec
			485.	Broncopneumonia Org Nos
			486.	Pneumonia, Organism Nos
			487.0	Influenza with Pneumonia
SIMPLE PNEUMONIA & PLEURISY AGE 18-69 W/O CC	90	.9618	480.9	Viral Pneumonia Nos
			481.	Pneumococcal Pneumonia
			482.2	H.Influenzae Pneumonia
			482.3	Streptococcal Pneumonia
			482.8	Bacterial Pneumonia Nec
			482.9	Bacterial Pneumonia Nos

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
			483.	Pneumonia: Organism Nec
			485.	Broncopneumonia Org Nos
			486.	Pneumonia, Organism Nos
			487.0	Influenza with Pneumonia
			511.0	Pleurisy W/O Effus or TB
PNEUMONIA				
BRONCHITIS & ASTHMA AGE >=70 &/OR CC	6	.7809	464.10	AC Tracheitis No Obstruc
			464.11	AC Tracheitis W Obstruct
			466.0	Acute Bronchitis
			466.1	Acute Bronchiolitis
			490.	Bronchitis Nos
			491.0	Simple Chr Bronchitis
			493.00	Ext Asthma W/O Stat Asth
			493.01	Ext Asthma W/O Stat Asth
			493.10	Int Asthma W/O Stat Asth
			493.90	Asthma W/O Status Asthm
			493.91	Asthma W Status Asthmat
			519.1	Trachea/Bronchus Dis Nec
HEART FAILURE & SHOCK	127	1.0164	398.91	Rheumatic Heart Failure
			402.01	Mal Hypert Hrt Dis W CHF
			402.11	Benign Hyp Hrt Dis W CHF
			402.91	Hyperten Heart Dis W CHF
			428.9	Heart Failure Nos
			785.50	Shock Nos
			785.51	Cardiogenic Shock
			785.59	Shock W/O Trauma Nec
PULMONARY EDEMA & RESPIRATORY FAILURE	87	1.5165	506.1	Fum/Vapaor Ac Pum Edema
			514.	Pulm Congest/Hypostasis
			518.4	Acute Lung Edema
			518.5	Post Traum Pulm Insuffic
			799.1	Respiratory Failure
ATHEROSCLEROSIS AGE >=70 &/OR CC	132	.8967	412.	Old Myocardial Infarct
			414.0	Coronary Atherosclerosis
			414.8	Chr Ischemic Hrt Dis Nec
			414.9	Chr Ischemic Hrt Dis Nos
			429.2	Ascvd
			429.3	Cardiomegaly
			429.89	Ill-Defined Hrt Dis Nec
			429.9	Heart Disease Nos
			459.89	Circulatory Disease Nec
			459.9	Circulatory Disease Nos
			793.2	ABN FD-Intrathor Org Nec

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
CEREBROVASCULAR DISEASE				
SPECIFIC CEREBROVASCULAR DISORDERS EXCEPT TIA	14	1.3210	430.	Subarachnoid hemorrhage
			431.	Intracerebral hemorrhage
			432.0	Nontraum extradural hem
			432.9	Intracranial hemorr nos
			434.0	Cerebral thrombosis
			434.1	Cerebral embolism
			434.9	Cerebr artery occlus nos
			436.	CVA
			437.3	Nonrupt cerebral aneurym
			784.3	Aphasia
SPECIFIC CEREBROVASCULAR DISORDERS EXCEPT TIA	14	1.3210	430.	Subarachnoid hemorrhage
			431.	Intracerebral hemorrhage
			432.0	Nontraum extradural hem
			432.9	Intracranial hemorr nos
			434.0	Cerebral thrombosis
			434.1	Cerebral embolism
			434.9	Cerebr artery occlus nos
			436.	CVA
			437.3	Nonrupt cerebral aneurym
			784.3	Aphasia
DEPRESSION				
DEPRESSIVE NEUROSES (MILDER DEPRESSION)	426	.9272	300.4	Neurotic Depression
			301.12	Chr Depressive Person
			309.0	Brief Depressive React
			309.1	Prolong Depressive React
			311.	Depressive Disorder Nec
			300.9	Neurotic Disorder Nos
			308.0	Stress React, Emotional
			308.1	Stress Reaction, Fugue
			308.2	Stress React, Psychomot
			308.3	Acute Stress React Nec
			308.4	Stress React, Mixed Dis
			308.9	Acute Stress React Nos
			780.1	Hallucinations
			799.2	Nervousness

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
		DEPRESSION		
PSYCHOSIS	430	1.0678	296.15	Recur Manic-Part Remiss
			296.16	Recur Manic-Full Remiss
			296.20	Depress Psychosis-Unspec
			296.21	Depress Psychosis-Mild
			296.22	Depressive Psychosis-Mod
			296.23	Depress Psychosis-Severe
			296.24	Depr Psychos-Sev W Psych
			296.25	Depr Psychos-Part Remiss
			296.26	Depr Psychos-Full Remiss
			296.30	Recurr Depr Psychos-Unsp
			296.31	Recurr Depr Psychos-Mild
			296.32	Recurr Depr Psychos-Mod
			296.33	Recur Depr Psych-Severe
			296.34	Rec Depr Psych-Psychotic
			296.35	Recur Depr Psyc-Part Rm
			296.36	Recur Depr Psych-Full Rem
			296.40	Bipol Aff, Manic-Unspec
			296.41	Bipolar Aff, Manic-Mild
			296.42	Bipolar Affec, Manic-Mod
			296.43	Bipol Aff, Manic-Severe
			296.44	Bipol Manic-Sev W Psych
			296.45	Bipol Aff Manic-Part Rem
			296.46	Bipol Aff Manic-Full Rem
			296.50	Bipolar Aff, Depr-Unspec
			296.51	Bipolar Affec, Depr-Mild
			296.52	Bipolar Affec, Depr-Mod
			296.53	Bipol Aff, Depr-Severe
			296.54	Bipol Depr-Sev W Psych
			296.55	Bipol Aff Depr-Part Rem
			296.56	Bipol Aff Depr-Full Rem
			296.60	Bipol Aff, Mixed-Unspec
			296.61	Bipol Aff, Mixed-Mild
			296.62	Bipolar Affec, Mixed-Mod
			296.63	Bipol Aff, Mixed-Severe
			296.64	Bipol Mixed-Sev Ww Psych
			296.65	Bipol Aff, Mix-Part Rem
			296.66	Bipol Aff, Mix-Full Rem
			296.7	Bipolar Affective Nos

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
PSYCHOSES (continued)	43-	1.0678	296.80	Manic-Depressive Nos
			296.81	Atypical Manic Disorder
			296.82	Atypical Depressive Dis
			296.89	Manic-Depressive Nec
			296.90	Affective Psychosis Nos
			296.99	Affective Psychoses Nec
			297.0	Paranoid State, Simple
			297.1	Paranoia
			297.2	Paraphrenia
			297.3	Shared Paranoid Disorder
			297.8	Paranoid States Nec
			297.9	Paranoid State Nos
			298.0	React Depress Psychosis
			298.1	Excitativ Type Psychosis
			298.3	Acute Paranoid Reaction
			298.4	Psychogen Paranoid Psych
			298.8	React Psychosis Nec/Nos
			298.9	Psychosis Nos
OTHER DIAGNOSES OF MENTAL DISORDERS	432	1.0278	298.2	Reactive Confusion
			302.0	Homosexuality
			302.1	Zoophilia
			302.2	Pedophilia
			302.3	Transvestism
DEPRESSION				
OTHER DIAGNOSES OF MENTAL DISORDERS (Continued)	432	1.0278	302.4	Exhibitionism
			302.50	Trans-Sexualism Nos
			302.51	Trans-Sexualism, Asexual
			302.52	Trans-Sexual, Homosexual
			302.53	Trans-Sex, Heterosexual
			302.6	Psychosex Identity Dis
			302.70	Psychosexual Dysfunc Nos
			302.71	Inhibited Sexual Desire
			302.72	Inhibited Sex Excitement
			302.73	Inhibited Female Orgasm
			302.74	Inhibited Male Orgasm
			302.75	Premature Ejaculation
			302.76	Functional Dyspareunia
			302.79	Psychosexual Dysfunc Nec
			302.81	Fetishism
			302.82	Voyeurism

Table A.1--continued

Principal DRG Diagnosis	DRG	Relative DRG Weight	ICD-9-CM	ICD-9-CM Diagnosis
			302.83	Sexual Masochism
			302.84	Sexual Sadism
			302.85	Gender Ident Dis, Adult
			302.89	Psychosexual Dis Nec
			302.9	Psychosexual Dis Nos
			306.8	Psychogenic Disorder Nec
			307.0	Stammering, Stuttering
			307.3	Stereotyped Movements
			307.40	Nonorganic Sleep Dis Nos
			307.41	Transient Insomnia
			307.42	Persistent Insomnia
			307.43	Transient Hypersomnia
			307.44	Persistent Hypersomnia
			307.45	Disrupt Sleep-Wake Cycle
			307.46	Somnambulism/Night Terror
			307.47	Sleep Stage Dysfunc Nec
			307.48	Repetit Sleep Intrusion
			307.49	Nonorganic Sleep Dis Nec
			307.50	Eating Disorder Nos
DEPRESSION				
OTHER DIAGNOSES OF MENTAL DISORDERS	432	1.0278	307.51	Bulimia
			307.59	Eating Disorder Nos
			780.50	Sleep Disturbance Nos
			780.52	Insomnia Nec
			780.54	Hypersomnia Nec
			780.55	Irreg Sleep-Wake Rhy Nos
			780.56	Sleep Stage Dysfunctions
			780.59	Sleep Disturbances Nec
			784.60	Symbolic Dysfunction Nos
ORGANIC DISTURBANCES & MENTAL RETARDATION	429	.9300	299.00	Infantile Autism-Active
			299.01	Infantile Autism-Resid
			317.	Mild Mental Retardation
			318.0	Mod Mental Retardation
			318.1	Severe Mental Retard
			318.2	Profound Mental Retard
			319.	Mental Retardation Nos
			758.0	Down's Syndrome
			758.1	Patau's Syndrome
			758.2	Edwards' Syndrome

Table A.2

SAMPLING GOALS FOR DEPRESSION

Pre-PPS

Hospital Status	PPS		Fee for Service		Total
	Unit	Scatterbed	Unit	Scatterbed	
Exempt unit	0	0	367	183	550
Nonexempt unit	0	0	267	133	400
Scatterbed	0	0	0	466	466
Total	0	0	634	782	1416

Post-PPS

Hospital Status	PPS		Fee for Service		Total
	Unit	Scatterbed	Unit	Scatterbed	
Exempt unit	0	183	367	0	550
Nonexempt unit	267	133	0	0	400
Scatterbed	0	466	0	0	466
Total	267	782	367	0	1416

from HCFA's 1984 MedPAR file to identify 21 hospitals with abundant depression records in categories where there are not many patients (e.g., the nonexempt unit and scatterbed rows) and including them in the sample. In effect this amounts to stratifying on "big depression" rather than "small depression" hospitals and oversampling the "big depression" stratum.

SAMPLING STUDY STATES

We used a multistage cluster sample with stratification, probability proportional to size allocation, and subsampling with units of unequal size for hospital and patient sampling. We chose five states in which PPS was employed and which had a rich diversity of hospital and patient types. We were unable to include a large northeastern state since Massachusetts, New York, and New Jersey used alternative reimbursement systems during the PPS study period. Within each state we collaborated with the PRO for the study.

Figure A.1 shows the states selected.

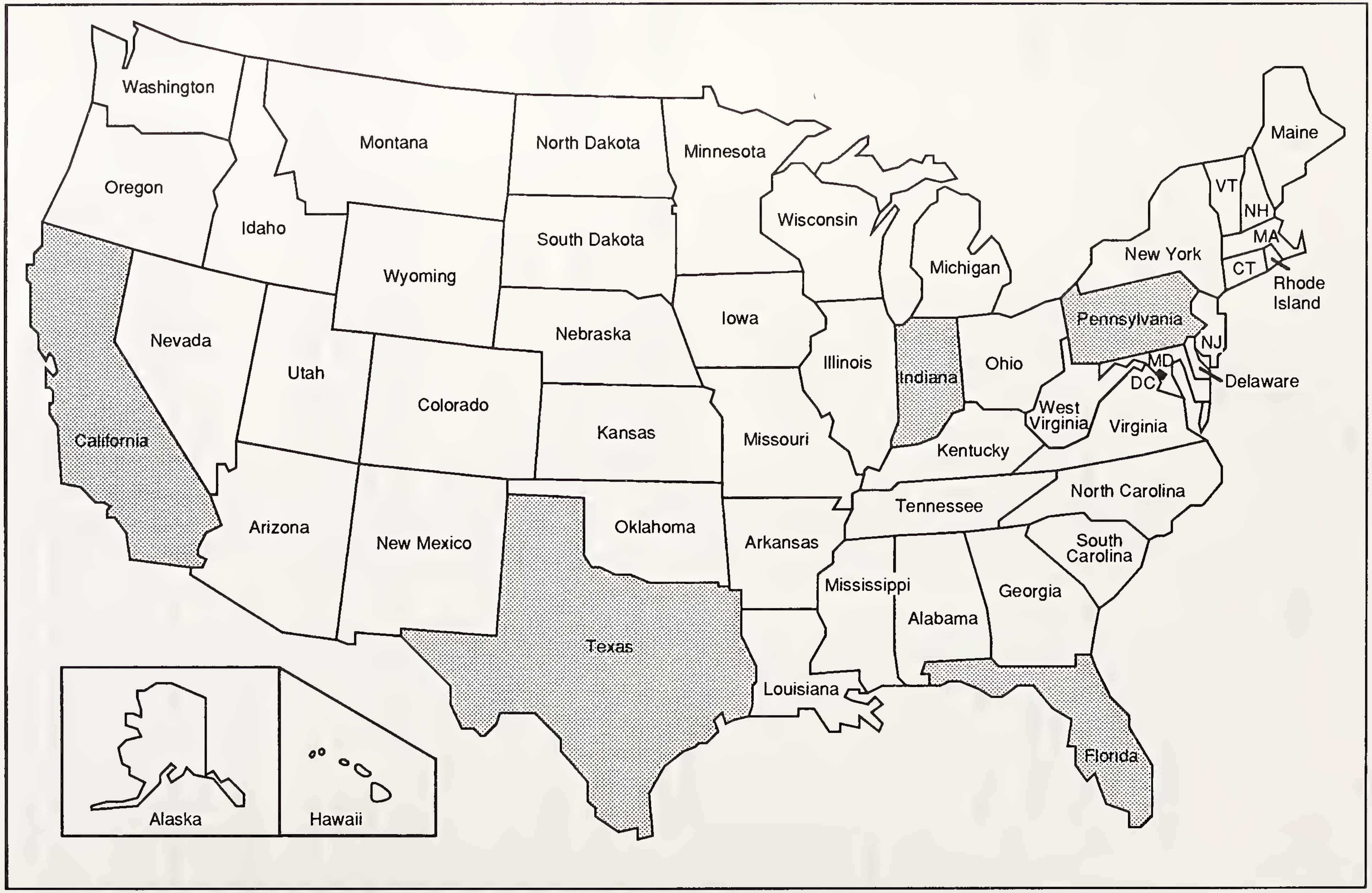

Fig. A.1—Sampling of study states

INSTRUMENT DEVELOPMENT AND DATA COLLECTOR PERFORMANCE

To measure quality of care we performed a detailed review of the medical record and used secondary databases to collect information about postdischarge outcomes. To collect data from the medical record we developed disease-specific abstraction forms, which guided the collection of data about clinical outcomes including death, clinical diagnoses, unstable complexes of symptoms and signs, and abnormal laboratory values (Kahn et al., 1988b; Kosecoff et al., 1988; Sherwood et al., 1988; Roth et al., 1988; Rubenstein et al., 1988; and Wells et al., 1988). We also collected detailed information about patient sickness at admission to compare clinical outcomes after adjustment for the conditions that were present at admission. In addition, we collected data about process measures using clinically detailed criteria. Some process criteria were applied to all patients; others were applied only to patients with a specific clinical condition. For example, we collected information about the completeness of a fever work-up only for patients with a temperature at or above a given level.

Data Collector Monitoring

During the period of data collection, the research team visited data collectors in the field at least once. A supervisory project manager spoke with the research team in each state at least weekly. In addition, data collectors and project managers were invited to call the RAND telephone hotline and speak with a physician about any questions that might arise in the field as they used the abstraction form to abstract medical records. Some phone calls were used to clarify the meaning of an item in the abstraction form or guidelines for a challenging patient problem. Other phone calls were used to discuss the best means for abstracting data given a patient situation that had not been previously anticipated.

The Abstraction Forms

The abstraction forms are divided into 14 sections:

1. Tear sheet for confidential patient demographics
2. Identification data noting patient, hospital, and abstractor code
3. Inclusion/exclusion criteria
4. Patient characteristics describing patient demographics
5. General medical history
6. Physician care
7. Nursing care, cardiac monitoring, and vital signs
8. Medications
9. X-rays
10. Electrocardiograms (EKGs)
11. Laboratory data
12. Special tests and procedures
13. Admission/discharge status
14. Completeness check

The abstraction form was designed to follow the format of a medical record so that abstraction would be both accurate and efficient. For each item or group of items, the section of the medical record that was to serve as the source of data was specified. For example, both physicians' and nurses' notes were sources of data for patient symptoms of shortness of breath. In addition, items derived from a particular portion of the medical record were grouped. Items likely to be found in the physician's notes were grouped in the physician care section of the abstraction form. Items likely to be found in the nurses' notes, or in documentation of cardiac monitoring and vital signs, were grouped in the nursing care section of the abstraction form. Data about use of medications were grouped in the medications section of the abstraction form. Data about X-rays, electrocardiograms, and laboratory studies were also grouped.

The pages of the abstraction form were color-coded by section to facilitate the location of the various sections as new data from the medical record were obtained.

Inclusion and Exclusion Criteria. Patients were included in the sample if they met three criteria. First, patients had to have been hospitalized within the time frame of the study: calendar year 1981, calendar year 1982, or July 1, 1985, through June 30, 1986. Second, the medical record itself was reviewed for ICD-9-CM codes. If the record had the specified ICD-9-CM code, or had no ICD-9-CM code listed (despite the hospital having a record of hospitalization with that code), the patient was considered eligible for inclusion. Third, the medical record was reviewed to determine if the actual clinical reason for hospitalization was as it should be for the sampled disease. For each disease, exclusion criteria were also reviewed (see below).

Demographics and Complexity. Data about demographics and patient complexity were collected for patients selected for inclusion in the study based upon the criteria listed above. Complexity was defined to measure patient sickness at admission based on the reason for the admission (morbid conditions) and on other conditions that might influence outcome or process (comorbid conditions). Both acute and chronic conditions were included as complexity measures. Efforts were made to collect data about complexity as close to admission as possible so that patient status at admission could be distinguished from patient status after the delivery of inhospital processes. Complexity data were collected in the patient information, general medical history, nursing care, and admission/discharge status sections of the abstraction form.

Process. The abstraction form is a guide for the collection of data about process, i.e., what is done to patients during the hospital stay. Data about both diagnostic assessments and therapeutics were collected by studying physician care and nursing care. Some process measures were collected for all patients; other process measures were collected only for subsets of patients for whom the process was relevant. Data about patient sickness during the hospital stay were collected to assure that process criteria could be matched to the patients' clinical needs.

Outcome. The abstraction form is also a guide for the collection of data about outcomes, i.e., what happens to patients during the hospital stay. Data were collected about death, clinical diagnoses, symptoms, signs, chest X-ray reports, and laboratory results. These data are collected from the physician care, chest X-ray, and laboratory sections of the abstraction form.

Patient Status at Discharge. Patient status at discharge is defined as the patient's clinical condition the day before and day of discharge. Data about the patient during this time period are collected from the physician care, nursing care (including vital signs and cardiac monitoring), chest X-ray, and laboratory sections of the abstraction form.

Guidelines for the Abstraction Form

To standardize the abstraction process, a detailed set of guidelines was prepared to accompany the abstraction form. The guidelines define medical terms, specify data sources from the medical record, and provide important medical synonyms. Each item in the abstraction form has a corresponding section in the guidelines. Despite the extensive guidelines, the field experience presented a number of unique patient problems. These were identified by data collectors in the field, supervisory project managers, or RAND researchers. To keep the data collectors aware of additions or changes in the guidelines, bimonthly updates were sent to each data collector during the abstraction process. These updates have been incorporated into the guidelines presented in Kahn et al. (1988b); Kosecoff et al. (1988); Roth et al. (1988); Rubenstein et al. (1988); Sherwood et al. (1988); and Wells et al. (1988).

DISEASE-SPECIFIC INCLUSION AND EXCLUSION CRITERIA

We used multiple criteria to assure a homogeneous group of patients with specified diseases in the pre- and post-PPS periods. First, we asked hospitals to provide a list of patients with our ICD-9-CM codes. The list was designed to include enough patients to allow an average of about 9.5 patients from each hospital with each disease to be included in the sample even though some records would be unavailable for review and some records would be inappropriate for the sample because of clinical considerations.

Second, we used clinical criteria to verify that the patient was at least 65 years of age, was admitted during a study year, and was hospitalized for the study disease. Patients with the study disease as a complication of hospitalization, rather than as a reason for admission, were not eligible for the sample. Except for depression, we did not include patients who were transferred from another acute care general hospital because we did not have access to the medical record from the initial hospital stay for those patients.

Third, we used disease-specific exclusion criteria to increase the likelihood of a homogeneous study sample across both time periods. Specifically, we excluded patients with major competing conditions (e.g., end stage cancer in a patient with congestive heart failure) that were likely to determine process and outcome for the patient regardless of the presence of the study disease on admission.

The following subsection lists the clinical inclusion and exclusion criteria for each study disease (except depression). Table A.3 summarizes the clinical exclusion criteria for each disease and allows the comparison of exclusion criteria across diseases.

Congestive Heart Failure Inclusion Criteria

1. Medical record for this admission shows any of the following ICD-9-CM codes for CHF:

   428.XX

   X is any value 0–9 or no value.

and 2. Patient has CHF as reason for admission.

   To be *included* patients must have at least one from (A) *and* at least one from (B) present at the time of hospital admission.

   (A) Current complaints or history of:

Table A.3

CLINICAL EXCLUSION CRITERIA FOR STUDY SAMPLE

Criterion	CHF	AMI	PNE	CVA	HIP
General					
No eligible ICD-9 codes	X	X	X	X	X
Age < 65 years	X	X	X	X	X
Transfer from another in-patient service	X	X	X	X	X
Not hospitalized in specified study year	X	X	X	X	X
Specified condition not the reason for admission	X	X	X	X	X
Any of the following conditions					
Cardiovascular					
Acute MI	X(1)		X(1)		X(2)
Cardiac arrest/sudden death	X(2)		X(2,3)		X(2,3)
Pulmonary					
Respiratory arrest/sudden death	X(2)		X(2)		X(2,3)
Lung cancer (primary or metastases)			X		
Interstitial lung disease at admission			X		
Active TB at admission			X		
Neurologic					
Acute CVA	X(2,4)				X(1)
Coma at admission	X				X
Multiple sclerosis				X	
Meningitis days 1 or 2				X	
Encephalitis days 1 or 2				X	
TIA (Sx's < 24 hr) or CVA > 2 weeks PTA				X	
CT scan - Subarachnoid bleed				X	
Subdural hematoma				X	
Brain cancer (primary or metastases)				X	
Renal					
Chronic dialysis	X			X	
Kidney transplant	X				
Metabolic					
Thyrotoxicosis	X				
Thiamine deficiency	X				
Paget's disease	X				

Table A.3--continued

Criterion	CHF	AMI	PNE	CVA	HIP
Musculoskeletal					
Bilateral hip fracture at admission					X
Femoral shaft fracture alone					X
Acetab/pelvic fracture alone					X
Prior fracture or surgery in currently fractured hip					X
Known cancer or metastases in fracture hip					X
Other					
Cancer newly Dx'd during the admission					X
Active cancer at admission	X				
Severe burns at admission					
Trauma is reason for admission	X			X	X
Major surgery performed during the admission	X		X		

(1) Present on any day 1 EKG.
(2) Within 48 hours before admission.
(3) In the emergency room.
(4) Newly diagnosed at admission.

(1) Shortness of breath, dyspnea, respiratory distress, orthopnea, paroxysmal nocturnal dyspnea (PND), tachypnea, rapid respiratory rate, difficulty breathing, wheezing.

Current diagnosis of:

(2) Pulmonary edema.

(3) CHF, congestive failure, left or right heart failure (LHF, RHF) or decompensation, left or right ventricular failure (LVF, RVF) or decompensation.

(4) Anasarca.

(B) (1) Chest X-ray report on days 1 or 2[1] describing CHF, congestive failure, left or right heart failure (LHF, RHF) or decompensation, left or right ventricular failure (LVF, RVF) or decompensation; engorgement, distention, plumpness, overload, increase, redistribution, congestion, prominence of pulmonary or hilar vessels (vasculature); increased pulmonary venous pressure; pulmonary congestion; interstitial or peribronchial or perivascular edema/congestion/infiltrate; Kerley B lines; peribronchial cuffing; pulmonary edema; edema in lung bases.

(2) Current signs on physical exam of anasarca, generalized edema, edema or swelling in lower extremities, pedal edema, ankle edema or swelling, pretibial edema. The edema may be described as pitting or nonpitting or X+ (where X = any number from 1 to 4) but is not described as unilateral.

Congestive Heart Failure Exclusion Criteria

A. Reasons for exclusion related to sampling:

1. ICD-9-CM code consistent with congestive heart failure is not listed.
2. Patient < 65 years old.
3. Patient not hospitalized in specified study year.
4. Patient transferred to this hospital from another acute care general hospital's inpatient service.
5. Congestive heart failure developed during the hospitalization and was not the reason for admission.

B. Clinical exclusions because patients with these conditions are significantly different from other patients with CHF who will constitute the sample:

1. Thyrotoxicosis.
2. Thiamine deficiency.
3. Paget's disease.
4. Chronic dialysis/renal transplant.

C. Clinical exclusions because the presence of these conditions will be the major determinants of processes and outcomes during this hospitalization (rather than the presence of CHF):

---

[1] If no chest X-ray report from days 1 or 2, use the physician description of the admission chest X-ray found in the history and physical, admitting note, consult reports, and discharge summary.

1. Acute MI present on admission as noted by *any* EKG on day 1 of admission showing an acute MI.
2. Acute CVA within 48 hours before admission.

   Note: Patients who have a new CVA noted on admission are excluded.
3. Arrest within 48 hours before admission.

   Note: Patients who arrest in the emergency room are not excluded.
4. Coma present on admission.
5. Coronary or valvular surgery during the admission.
6. Cancer known to be active at admission.
7. Multiple trauma as reason for admission.
8. Major surgery occurred during the admission.

Acute Myocardial Infarction Inclusion Criteria

1. Medical record for this admission shows any of the following ICD-9-CM codes for acute myocardial infarction:

   410.XX

   X is any value 0 to 9 or no value.

and 2. Patient has an acute MI as reason for admission.

Acute Myocardial Infarction Exclusion Criteria

A. Reasons for exclusion related to sampling:

1. ICD-9-CM code consistent with MI is not listed.
2. Patient < 65 years old.
3. Patient not hospitalized in specified study year.
4. Patient transferred to this hospital from another acute care general hospital's inpatient service.
5. MI occurred during the hospitalization and was not the reason for admission.

B. Reasons for exclusion related to systemic illness:

None.

Pneumonia Inclusion Criteria

1. Medical record for this admission shows any of the following ICD-9-CM codes for pneumonia:

   480.9X
   481.XX
   482.XX
   483.XX
   485.XX

486.XX
487.0X
507.0X
510.XX
511.1X
513.0X
799.1X

X is any value 0 to 9 or no value.

and 2. Patient has pneumonia as reason for admission. The presence of pneumonia on admission is noted as at least one from (A) *and* at least one from (B):

(A) Infiltrate or pneumonia noted on the physician's note or radiologist's report of the preadmission or admission chest X-ray.

(B) Any of the following symptoms or signs noted on the day of admission:

(1) fever ≥ 101° F or 38.2° C.
(2) WBC ≥ 15,000.
(3) WBC differential ≥ 90 percent polys (regardless of WBC).
(4) WBC differential ≥ 15 percent bands (regardless of WBC).
(5) New onset cough or sputum production.

Pneumonia Exclusion Criteria

A. Reasons for exclusion related to sampling:

1. ICD-9-CM code consistent with pneumonia is not listed.
2. Patient < 65 years old.
3. Patient not hospitalized in specified study year.
4. Patient transferred to this hospital from another acute care general hospital's inpatient service.
5. Pneumonia developed during the hospitalization and was not the reason for admission.

B. Clinical exclusions because patients with these clinical conditions are significantly different from other patients with pneumonia who will constitute the sample:

1. Primary or metastatic lung cancer known at admission.
2. Interstitial lung disease known at admission.
3. Active pulmonary tuberculosis known at admission.

C. Clinical exclusions because the presence of these conditions will be the major determinants of processes and outcomes during this admission (rather than the presence of pneumonia):

1. Acute MI present on admission as noted by *any* EKG on day 1 of admission showing an acute MI.
2. Arrest within 48 hours before admission because it cannot be determined if the primary event was pulmonic or cardiac.

Note: Patients who arrest in the emergency room are not excluded when they have an apparent respiratory arrest as a sequel to the pneumonia which was the reason for the admission.

3. Major surgery occurred during this admission.

   Note: Patients with surgical procedures which are performed as part of the management of the pneumonia (i.e., lung biopsy, bronchoscopy) will not be excluded.

Cerebrovascular Accident Inclusion Criteria

1. Medical record for this admission shows any of the following ICD-9-CM codes for cerebrovascular accident:

   431.XX
   434.XX
   436.XX

   X is any value 0 to 9 or no value.

and 2. Patient has new CVA as reason for admission. The presence of a new onset CVA is defined as the presence of new onset (≤ 2 weeks before admission) paresis, paralysis, or weakness lasting more than 24 hours.

Cerebrovascular Accident Exclusion Criteria

A. Reasons for exclusion related to sampling:

1. ICD-9-CM code consistent with CVA is not listed.
2. Patient ≤ 65 years old.
3. Patient not hospitalized in specified study year.
4. Patient transferred to this hospital from another acute care general hospital's inpatient service.
5. Acute CVA occurred during the hospitalization and is not the reason for admission.
6. Acute CVA occurred more than 2 weeks before admission, i.e., patient had CVA diagnosed or symptoms of paralysis, paresis, or weakness ≥ 2 weeks before admission.
7. Patient did not have a stroke, but had a TIA, i.e., symptoms of paresis, paralysis, weakness were transient, lasting ≤ 24 hours.

B. Clinical exclusion because patient has a competing clinical condition which will be the predominant determinant of processes and outcomes, rather than CVA:

1. Multiple sclerosis.
2. Head trauma.
3. Chronic dialysis.
4. Meningitis known on days 1 or 2 of admission.
5. Encephalitis known on days 1 or 2 of admission.

6. C-T scan shows any of the following:
    - a. subarachnoid bleed.
    - b. subdural hematoma.
    - c. primary or metastatic brain cancer.

Hip Fracture Inclusion Criteria

1. Medical record for this admission shows any of the following ICD-9-CM codes for hip fracture:

   820.0X (except 820.01)
   820.2X
   820.8X

   X is any value 0 to 9 or no value.

and 2. Patient has a hip fracture as reason for admission.

Hip Fracture Exclusion Criteria

A. Reasons for exclusion related to sampling:

1. ICD-9-CM code consistent with hip fracture is not listed.
2. Patient < 65 years old.
3. Patient not hospitalized in specified study year.
4. Patient transferred to this hospital from another acute care general hospital's inpatient service.
5. Hip fracture occurred during the hospitalization and was not the reason for admission.

B. Clinical exclusions because patients with this hip pathology are significantly different from other patients with hip fracture who will be in the sample:

1. Known cancer/metastases in fractured hip.
2. Current bilateral hip fracture.
3. Femoral shaft fracture without hip fracture.
4. Acetabular/pelvic fracture without hip fracture.
5. Prior fracture or surgery in currently fractured hip.

C. Clinical exclusion because the presence of these conditions will be the major determinants of processes and outcomes during this hospitalization (rather than the presence of the hip fracture):

1. Acute MI within 48 hours before admission.
2. Arrest within 48 hours before admission.

   Note: Patients who arrest in the emergency room are excluded.
3. Acute CVA within 48 hours before admission.
4. Coma at admission.

5. Multiple trauma as reason for admission.
6. New cancer (other than basal cell) diagnosed during the admission.

FLOW DIAGRAMS REPRESENTING DISEASE-SPECIFIC EXCLUSION CRITERIA

Tables A.4 through A.8 are flow diagrams for each disease-specific exclusion criterion.

DISTRIBUTION OF PATIENTS BY CLINICAL EXCLUSION CRITERIA FOR PRE- AND POST-PPS SAMPLE COMBINED

Patients were selected for possible inclusion in the study sample if, according to hospital records, the patient was hospitalized in one of the study years. The medical record of each of these patients was reviewed to verify that the patient did meet the disease-specific clinical inclusion and exclusion criteria. Tables A.9 through A.14 show the distribution of cases excluded for each disease by reason for exclusion and study period.

Table A.15 shows the most frequent reasons that medical records were excluded from the study sample across diseases. This summary allows comparison of the frequency of exclusions across diseases for the pre- and post-PPS sample combined.

ACUTE CARE HOSPITAL TRANSFERS AND PPS EFFECT

As noted in Table A.15, we excluded records from the analysis if patients were transferred to the study hospital from another acute care general hospital, since in these cases we would not have access to the medical record from the initial hospital stay. The table shows that the fraction of patients excluded because of transfers dropped somewhat in the post-PPS period for every disease except myocardial infarction. This decline is statistically significant for stroke and approaches significance both for hip fracture and for all diseases combined; the increase in transfer rate for AMI is statistically significant in the other direction. This evidence suggests that PPS implementation has affected the rate of patient transfers between acute care general hospitals. The declines in transfer rates are consistent with financial incentives provided by PPS.

For hip fracture, we also noted a reduction in the number of patients initially hospitalized for the fracture at one of the study hospitals but then transferred elsewhere for surgery. During the pre-PPS period 5.4 percent of patients were transferred from one of the study hospitals for surgery. This number dropped to 1.7 percent of patients in the post-PPS period.

Review of the hospital-generated lists of patients organized by ICD-9-CM code and year provides additional supportive evidence for the trend. During the pre-PPS period, five of the 297 study hospitals admitted no patients with hip fractures, whereas 11 hospitals during the post-PPS period had no such patients. This suggests that before PPS implementation, some hospitals admitted patients with hip fractures and transferred them for surgery as needed. Following PPS implementation, it appears that hospitals without surgical facilities were less likely to admit such patients. In the latter period, it appears patients were triaged to hospitals with surgical capabilities before, rather than during, admission to the hospital without surgical capability.

During the pre-PPS period, both the initial and receiving hospitals were reimbursed in proportion to their charges. However, under DRG-based prospective payment, the fixed

Table A.4

Congestive Heart Failure Exclusion Map

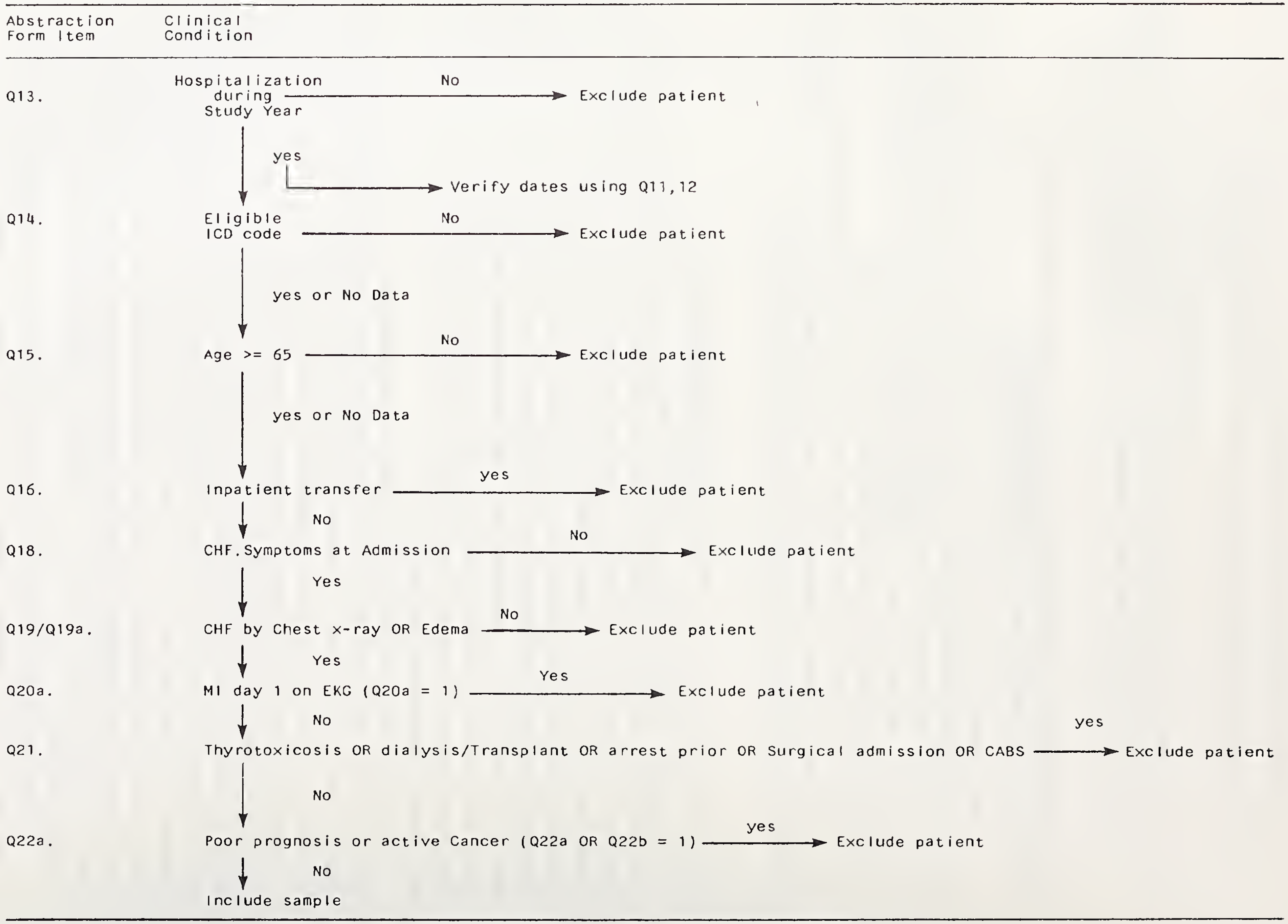

Table A.5

Acute Myocardial Infarction Exclusion Map

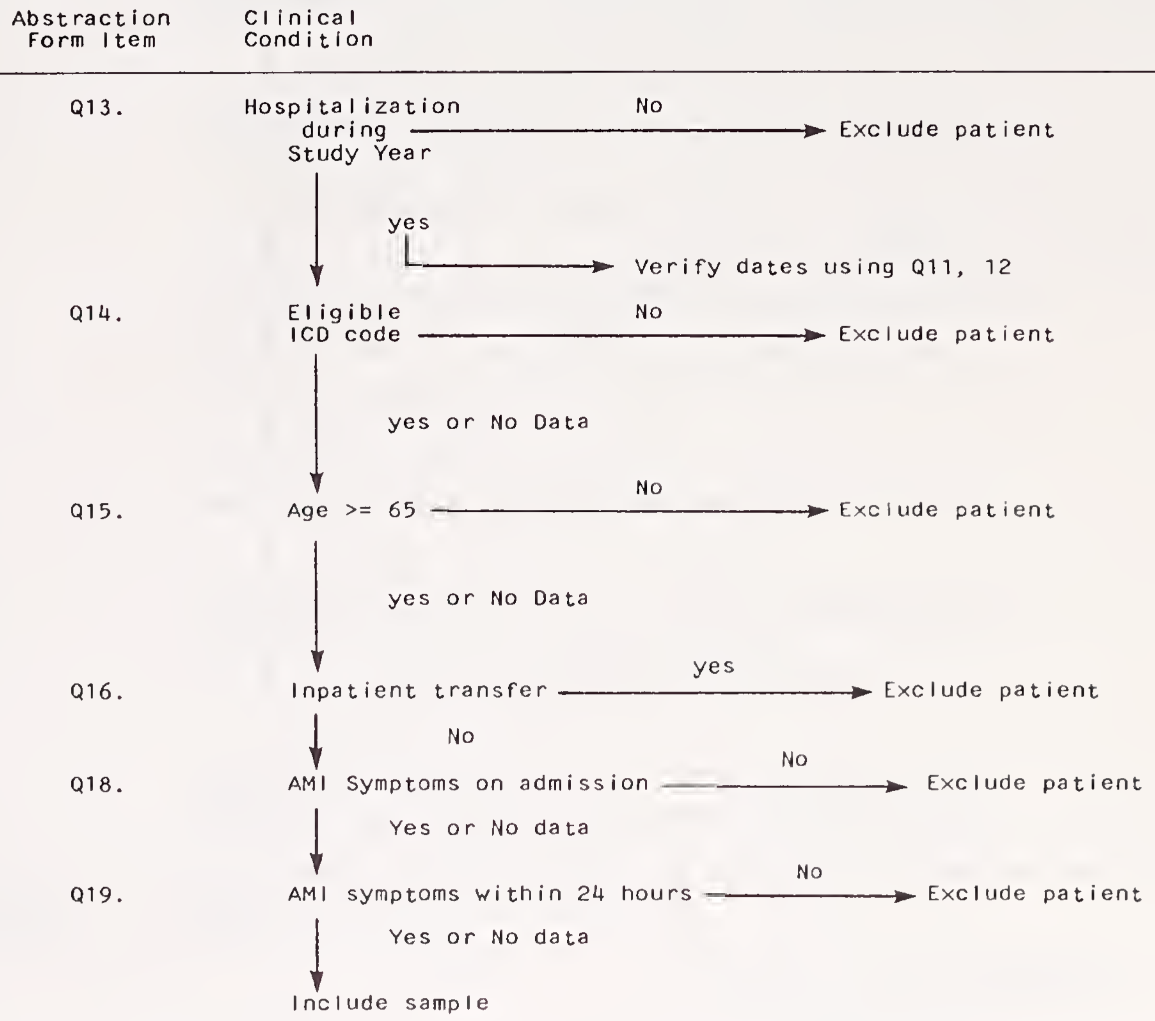

Table A.6

Pneumonia Exclusion Map

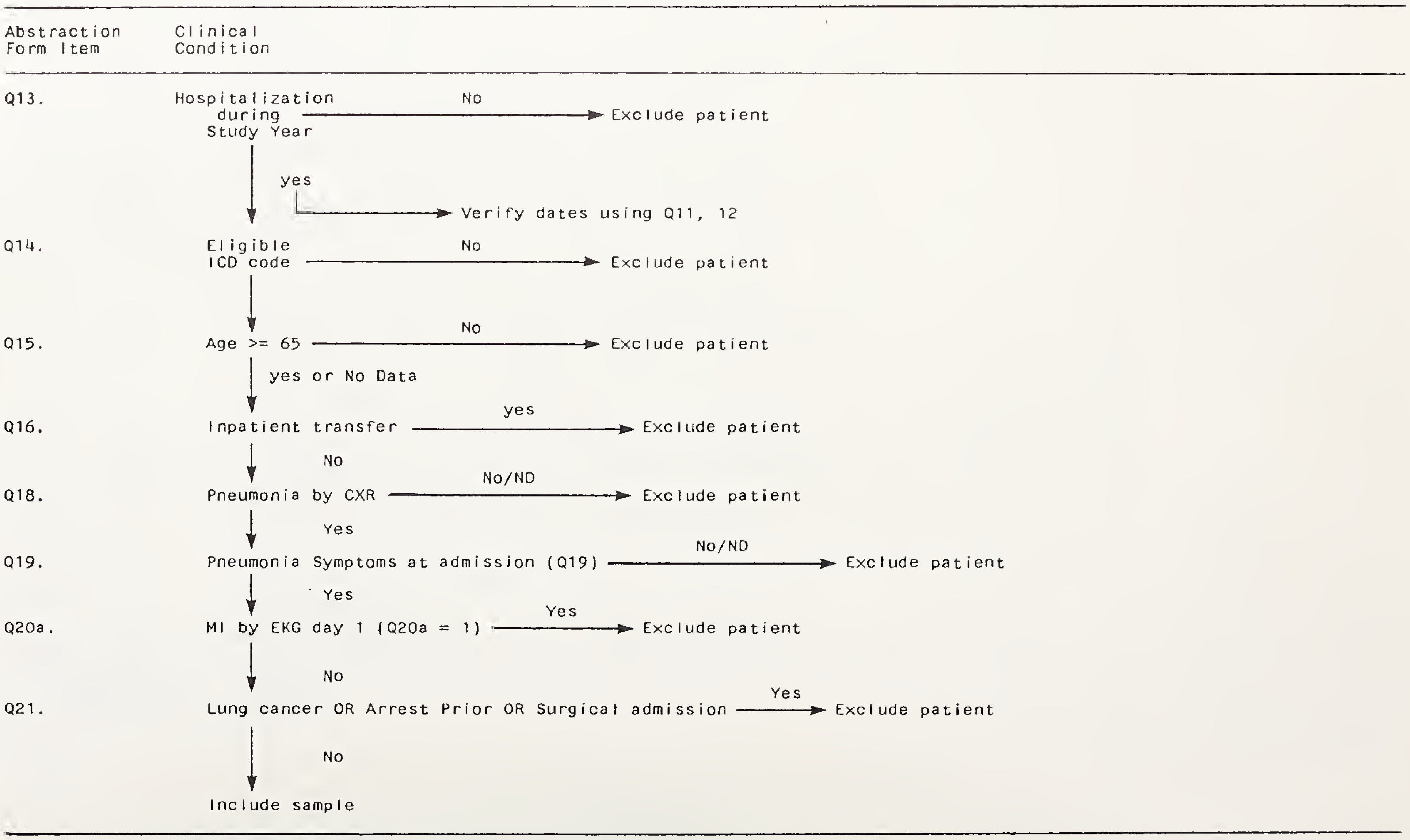

Table A.7

Cerebrovascular Accident Exclusion Map

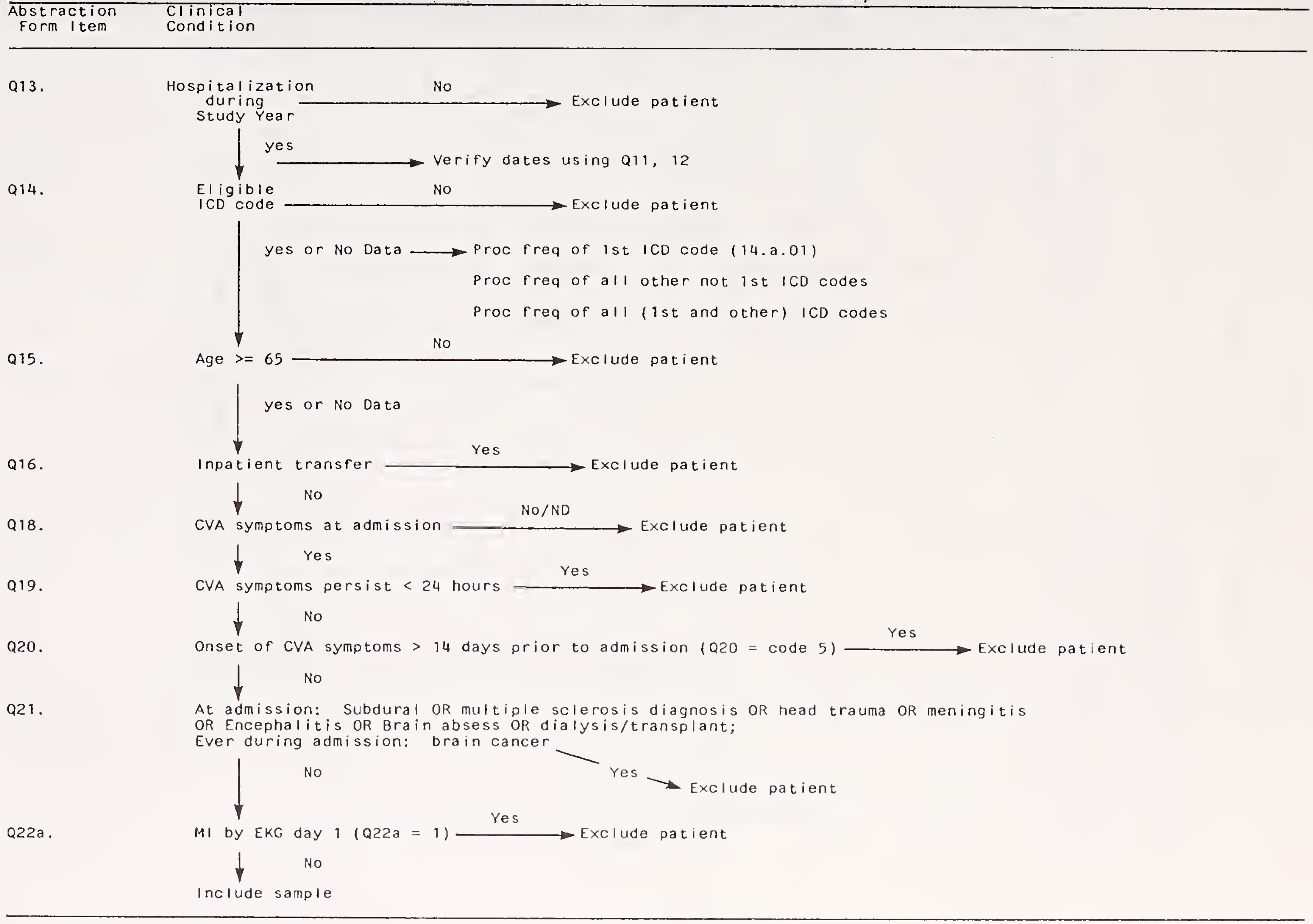
Abstraction Form Item
Clinical Condition
Q13.
Hospitalization during Study Year
No
Exclude patient
yes
Verify dates using Q11, 12
Q14.
Eligible ICD code
No
Exclude patient
yes or No Data
Proc freq of 1st ICD code (14.a.01)
Proc freq of all other not 1st ICD codes
Proc freq of all (1st and other) ICD codes
Q15.
Age >= 65
No
Exclude patient
yes or No Data
Q16.
Inpatient transfer
Yes
Exclude patient
No
Q18.
CVA symptoms at admission
No/ND
Exclude patient
Yes
Q19.
CVA symptoms persist < 24 hours
Yes
Exclude patient
No
Q20.
Onset of CVA symptoms > 14 days prior to admission (Q20 = code 5)
Yes
Exclude patient
No
Q21.
At admission: Subdural OR multiple sclerosis diagnosis OR head trauma OR meningitis OR Encephalitis OR Brain absess OR dialysis/transplant;
Ever during admission: brain cancer
Yes
Exclude patient
No
Q22a.
MI by EKG day 1 (Q22a = 1)
Yes
Exclude patient
No
Include sample

Table A.8

Hip Fracture Exclusion Map

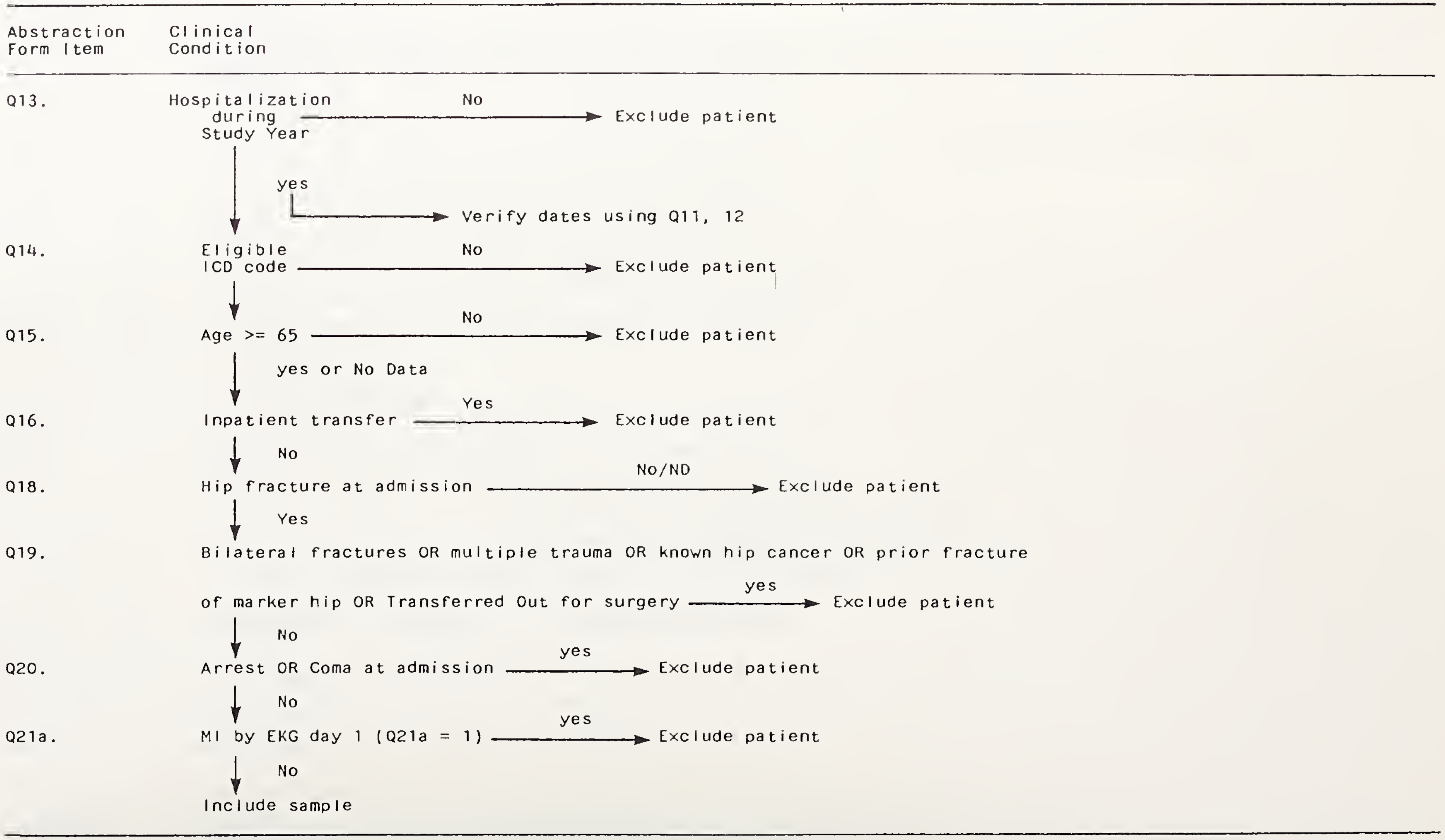

Table A.9

REASONS FOR EXCLUSION: CONGESTIVE HEART FAILURE

Reason for Exclusion	Distribution of Cases, % All (n=3740)	 Pre-PPS (n=1915)	 Post-PPS (n=1825)
Not admitted during study periods (1)	0.3	--	--
No eligible ICD-9-CM code	1.0	1.5	0.6
Age less than 65	0.2	0.2	0.3
Transferred from another acute care hospital	1.8	2.0	1.5
No symptoms of CHF at admission	5.2	7.2	3.0
Neither chest X-ray evidence for CHF nor leg edema	11.6	14.0	9.1
Acute myocardial infarction at admission	0.7	1.1	0.3
Thyrotoxicosis or chronic dialysis or renal transplant or arrest immediately before admission or major surgery during admission	1.3	1.1	1.7
Poor prognosis cancer or active cancer or current chemotherapy or radiotherapy	1.8	1.2	2.4

(1) This is the total number of cases excluded/total number of cases included and excluded regardless of study period since we do not have an accurate year of hospitalization for these patients.

Table A.10

REASONS FOR EXCLUSION: ACUTE MYOCARDIAL INFARCTION

	Distribution of Cases, %		
Reason for Exclusion	All (n=3403)	Pre-PPS (n=1717)	Post-PPS (n=1686)
Not admitted during study periods (1)	0.4	--	--
No eligible ICD-9-CM code	1.5	2.1	0.8
Age less than 65	0.3	0.1	0.4
Transferred from another acute care hospital	4.1	3.3	4.9
No symptoms of AMI at admission	6.5	8.0	5.0
No symptoms of AMI during the 24 hours immediately before admission	2.2	2.3	2.0

(1) This is the total number of cases excluded/total number of cases included and excluded regardless of study period, since we do not have an accurate year of hospitalization for these patients.

Table A.11

REASONS FOR EXCLUSION: PNEUMONIA

Reason for Exclusion	Distribution of Cases, %		
	All (n=4381)	Pre-PPS (n=2184)	Post-PPS (n=2197)
Not admitted during study periods (1)	0.2	--	--
No eligible ICD-9-CM code	1.6	1.9	1.2
Age less than 65	0.5	0.5	0.5
Transferred from another acute care hospital	1.8	1.9	1.7
No chest X-ray evidence for pneumonia	22.5	23.7	21.1
No symptoms, signs, or laboratory data suggesting pneumonia at admission	5.0	4.9	5.1
Acute myocardial infarction at admission	0.2	0.2	0.1
Known lung cancer diagnosis or arrest immediately before admission or major surgery during admission	3.6	3.1	4.1

(1) This is the total number of cases excluded/total number of cases included and excluded regardless of study period, since we do not have an accurate year of hospitalization for these patients.

Table A.12

REASONS FOR EXCLUSION: CEREBROVASCULAR ACCIDENT

	Distribution of Cases, %		
Reason for Exclusion	All (n=3432)	Pre-PPS (n=1772)	Post-PPS (n=1660)
Not admitted during study periods (1)	0.3	--	--
No eligible ICD-9-CM code	1.2	1.4	1.0
Age less than 65	0.3	0.2	0.4
Transferred from another acute care hospital	3.3	4.4	2.2
No symptoms or signs of CVA at admission	5.5	7.5	3.4
CVA symptoms or signs persist < 24 hours	2.5	2.2	2.8
Onset of CVA symptoms > 14 days before admission	3.0	4.1	1.9
Subdural hematoma, head trauma, meningitis, encephalitis, or brain abscess at admission; or history of central nervous system malignancy, chronic dialysis, or transplant	0.6	0.6	0.7
Acute myocardial infarction at admission	0.3	0.5	0.2

(1) This is the total number of cases excluded/total number of cases included and excluded regardless of study period, since we do not have an accurate year of hospitalization for these patients.

Table A.13

REASONS FOR EXCLUSION: HIP FRACTURE

Reason for Exclusion	Distribution of Cases, %		
	All (n=3343)	Pre-PPS (n=1694)	Post-PPS (n=1649)
Not admitted during study periods (1)	0.3	--	--
No eligible ICD-9-CM code	1.5	2.2	0.7
Age less than 65	0.1	0.1	0.1
Transferred from another acute care hospital	2.2	2.6	1.2
No hip fracture at admission	1.9	2.0	2.5
Bilateral hip fractures or multiple trauma or known hip cancer or prior ipsilateral hip fracture	10.2	11.1	9.3
Transferred to another hospital for surgery	3.6	5.4	1.7
Arrest or coma at admission	0.1	0.1	0.1
Acute myocardial infarction at admission	0.2	0.1	0.3

(1) This is the total number of cases excluded/total number of cases included and excluded regardless of study period, since we do not have an accurate year of hospitalization for these patients.

Table A.14

REASONS FOR EXCLUSION: DEPRESSION

Reason for Exclusion	Distribution of Cases, % All (n=3626)	Pre-PPS (n=2045)	Post-PPS (n=1581)
Not all volumes of medical record for study are available (1)	0.5	0.0	0.1
Not admitted during study periods (2)	0.2	--	--
No eligible ICD-9-CM code	2.5	2.6	2.2
Age less than 65	0.7	0.5	0.9
No depression at admission	10.9	12.7	8.6
Arrest, acute myocardial infarction, cerebrovascular accident, or major trauma at admission; or chronic dialysis; or major surgery during admission	2.6	2.2	3.0
Poor prognosis or active cancer, or current chemotherapy or radiotherapy	1.2	1.0	1.6

(1) The pre (0 percent) and post (0.1 percent) do not average to the all patients' value (0.5 percent) because 18 of the 19 records that were excluded with "not all volumes of the medical record for the study hospitalization were available" were not eligible for one of the study years.

(2) This is the total number of cases excluded/total number of cases included and excluded regardless of study period, since we do not have an accurate year of hospitalization for these patients.

Table A.15

FREQUENT REASONS FOR EXCLUDED RECORDS FOR SIX DISEASES BY PPS PERIOD

	CHF		AMI		PNE		CVA		HIP		DEP	
	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)	Pre (%)	Post (%)
No Eligible ICD-9-CM code	1.5	0.6	2.1	0.8	1.9	1.2	1.4	1.0	2.2	0.7	2.6	2.2
Age < 65	0.2	0.3	0.1	0.4	0.5	0.5	0.2	0.4	0.1	0.1	0.5	0.9
Transferred from another acute care hospital	2.0	1.5	3.3	4.9	1.9	1.7	4.4	2.2	2.6	1.8	---	---
No symptoms/signs of disease at admission	21.2	12.1	10.3	7.0	28.6	26.0	13.8	8.1	2.5	2.0	3.2	4.6
Acute myocardial infarction at admission	1.1	0.3	---	---	0.2	0.1	0.5	0.2	0.1	0.3	2.2	3.0
Other competing conditions	1.1	1.7	---	---	3.1	4.1	0.6	0.7	11.2	9.4	1.0	1.6
Poor prognosis or active cancer	1.2	2.4	---	---	---	---	---	---	---	---	0.9	1.9
Total number of Excludes and Includes	1915	1825	1717	1686	1772	1660	1694	1649	2184	2197	2045	1581

payment is divided between the two hospitals, providing a disincentive to receiving hospitals for transfer of expensive patients.

ACTUAL HOSPITAL AND PATIENT SAMPLE PLAN

Because the actual sample could not be finalized until after patient records were reviewed for clinical inclusion and exclusion criteria, the details of the sampling plan at the patient level within hospitals were designed to adapt to the number of included, excluded, and not available records found in the field. In each hospital we set targets for the number of records planned by disease and study year, as exemplified in Table A.16. Each hospital had a 3 by 6 table of sampling goals similar to the ones in Table A.16. Records were abstracted in each cell of a given hospital's table until the goal was met or the available supply of relevant records was exhausted. In the latter case, abstractors were instructed to choose another record with the same disease and, when possible, in the same pre- or post-PPS time period (e.g., if the target for pneumonia in 1982 could not be met, the shortfall was made up if possible with pneumonia records from 1981). In 73 percent of the hospital-disease combinations, the initial target set by RAND was met without adjustments (see Table A.17).

SPECIAL FEATURES OF THE SAMPLING PLAN

The sampling plan we employed had four features requiring special attention during the analysis: our oversampling of poor patients, the clustering of our patients in a relatively small number of hospitals, the longitudinal nature of the design at the hospital level, and the aggregation of our results across diseases. We now describe these features and how we dealt with them. This discussion extends the one in Sec. II and provides additional details.

OVERSAMPLING OF POOR PATIENTS

Our oversampling of patients from hospitals serving an unusually large fraction of Medicaid patients would yield somewhat biased raw findings if the quality of care in high-Medicaid facilities differs substantially from that in other hospitals. To arrive at nationally representative findings, it was necessary to reweight our raw patient-level results, giving less weight to patients from high-Medicaid facilities. We describe in Sec. II how we calculated the weights for this purpose. The weighted and unweighted results differed little in most of our major analyses; we therefore presented unweighted findings (unless otherwise indicated).

The only major result that was even partially affected by this reweighting arose in the analysis of outcomes (Sec. VII). Unweighted mortality rates 30 days after admission, adjusted for sickness at admission, for our study diseases combined (excluding depression) were 16.7 percent pre-PPS and 15.7 percent post-PPS. This difference of 1.0 percentage points (95 percent confidence interval –0.1 percent to 2.1 percent) was significant at the $p = 0.07$ level. When we reweighted to the nation, downweighting the high-Medicaid hospitals, the pre- and post-PPS 30-day adjusted mortality rates aggregating across our five diseases became 16.5 percent and 15.4 percent, respectively. The reweighted difference was thus 1.1 percentage points (95 percent confidence interval 0.0 percent to 2.2 percent), and the p-value dropped to 0.04. This discrepancy will give pause only to readers who believe that there is

Table A.16

PATIENT SAMPLING TARGETS AT THE HOSPITAL LEVEL

(a) The idealized table

	HIP	AMI	CHF	PNE	CVA	DEP	total
1981	1.9	1.9	1.9	1.9	1.9	1.9	11.3
1982	2.8	2.8	2.8	2.8	2.8	2.8	17.0
1985/6	4.7	4.7	4.7	4.7	4.7	4.7	28.3
total	9.4	9.4	9.4	9.4	9.4	9.4	56.7

(b) A typical table for a nondepression hospital

	HIP	AMI	CHF	PNE	CVA	DEP	total
1981	2	2	2	2	2	2	12
1982	2	3	2	3	3	4	17
1985/6	6	5	6	5	5	2	29
total	10	10	10	10	10	8	58

(c) A typical table for a depression hospital

	HIP	AMI	CHF	PNE	CVA	DEP	total
1981	2	1	1	1	2	5	12
1982	2	2	2	2	2	7	17
1985/6	4	4	4	4	4	10	30
total	8	7	7	7	8	22	59

NOTE: These targets were based on a 20 percent, 30 percent, and 50 percent allocation of records in the study years 1981, 1982, and 1985/6 (with a roughly equal division of the 50 percent post-PPS records between 1985 and 1986), and a goal of balance across diseases conditional on the depression status of the hospital. The number of records targeted at a given hospital varied from 57 to 60, depending on the hospital's size, to allow for a modest shortfall of the sampling goals in some of the very smallest hospitals.

Table A.17

HOSPITAL-LEVEL COMPARISON OF SAMPLING GOALS AND ACTUAL SAMPLE CHOSEN

Disease	Result	Hospitals (n=297)	Number of Records
Acute myocardial infarction	Target met--no adjustments	253	
	Target met with adjustments	27	
	Target not met	13	-24 (0.8% of target)
	Target surpassed	4	+4
Congestive heart failure	Target met--no adjustments	223	
	Target met with adjustments	49	
	Target not met	18	-35 (1.2% of target)
	Target surpassed	7	+8
Hip fracture	Target met--no adjustments	244	
	Target met with adjustments	29	
	Target not met	24	-45 (1.6% of target)
	Target surpassed	0	0
Pneumonia	Target met--no adjustments	157	
	Target met with adjustments	85	
	Target not met	45	-112 (3.9% of target)
	Target surpassed	10	+10
Cerebro-vascular accident	Target met--no adjustments	243	
	Target met with adjustments	41	
	Target not met	7	-19 (0.7% of target)
	Target surpassed	6	+7
Depression	Target met--no adjustments	181	
	Target met with adjustments	49	
	Target not met	62	-107 (3.7% of target)
	Target surpassed	5	+9

something special about the 0.05 level. In fact, the weight of evidence about the difference in 30-day adjusted mortality rates for our five diseases associated with the introduction of PPS is essentially the same with and without weighting.

Hospital-Level Clustering

The clustering of our sampled patients in only five states, 30 areas, and 297 hospitals has implications for the accuracy of our results. If there is more similarity on average between two patients in the same state, area, or hospital in the care they receive than between two patients in different states, areas, or hospitals, and no adjustment for this intracluster correlation is made, the result will be an overstatement of the precision of our findings. To adjust for the clustering and to produce standard errors that accurately reflect the information content of our sample, we (a) calculated provisional standard errors for all of our major estimates as if we had gathered our data using simple random sampling, (b) computed "inflation factors" based on intracluster correlations that measured the amount of information in our sample relative to that obtained in a simple random sample of the same size, and (c) multiplied our provisional standard errors by the inflation factors, thereby adjusting the significance of our results downward.

To compute the inflation factors in step (b) of this analysis, we performed analyses of covariance with the following factors: state; area nested within state; hospital nested within area, pre- and post-PPS crossed with state, area, and hospital; patient nested within the cross of pre- and post-PPS and hospital; and any patient-specific covariates needed for adjustment purposes such as sickness at admission. State and area were typically not as important as hospital in determining the magnitude of the information loss resulting from clustering, so the inflation factors were given approximately by the square root of the expression $[1 + (M - 1) r]$, where M is the average number of patients per hospital and r is the intracluster correlation for the given outcome.

The inflation factors ranged from 1.1, for outcomes such as in-hospital and 30-day death, to 2.9 for our overall explicit process score, aggregating across diseases. The latter inflation factor, which derives from an unusually high intracluster correlation of 0.16, indicates a remarkable degree of homogeneity within hospitals in the processes of care rendered. A correlation of 0.16 may not seem large, but it must be remembered that this is the correlation between process scores for two completely different individuals, not even necessarily with the same disease, in the same hospital treated in the same (pre- compared with post-PPS) time period. The corresponding intracluster correlation for 30-day mortality was only 0.003.

Adjustment for the Longitudinal Design at the Hospital Level

Our design was longitudinal at the hospital level; i.e., we gathered data in all our hospitals in both the pre- and post-PPS periods. This gives the analysis the character of a paired comparison, in which hospital is held constant. This hospital-level pairing, like the hospital-level clustering, has implications for the accuracy of our results. The pairing acted upon the precision of our findings in a manner opposite to that of the clustering: The clustering decreased accuracy, when compared with independent simple random sampling in each of the pre- and post-PPS periods, whereas the pairing increased accuracy, because of correlations over time in the patterns of care given to patients within hospitals.

To account for the pairing, we again fit analysis of variance models similar to those mentioned above in the clustering discussion, to quantify the extent to which data from a given hospital pre-PPS are correlated with data from the same hospital post-PPS. The results paralleled those described in the clustering discussion: low across-period correlations for death outcomes and high correlations for process.

As an example of the process results, the correlation between the mean process score in a given hospital in the pre-PPS period, aggregating across all five diseases, and the mean process score in the same hospital in the post-PPS period is +0.73. This is an ecological correlation, in which the means being correlated are each based on an average of 23.6 patients per hospital; since averaging is a smoothing process that damps out patient-level variation, this correlation is much higher than the corresponding patient-level process correlation. When this effect was accounted for, we discovered that the correlation between the process scores for two patients chosen from the same hospital, one pre-PPS and one post-PPS (the correlation relevant to the pairing), is quite close to the correlation between the process scores for two patients chosen from the same hospital in the same time period (the correlation relevant to the clustering). This implied that when we computed "deflation factors," analogous to the clustering "inflation factors," to adjust simple random sampling standard errors for the pairing, the clustering and pairing effects approximately canceled each other. Thus, interestingly, in the end we were able to analyze our data essentially as if they had been gathered with simple random sampling in an unpaired fashion.

Aggregating Across Diseases

Two issues arise in producing across-disease summaries: reweighting the diseases back to their actual frequencies in the Medicare population, and properly accounting for the degree to which pre- and post-PPS differences themselves differ by disease (i.e., accounting for interactions between the pre- and post-PPS and disease factors).

Reweighting by disease prevalence is potentially necessary because we took samples of roughly equal size in each of our six diseases, even though congestive heart failure is more than three times more frequent among Medicare patients than hip fracture, for example. We computed weights necessary to reweight our raw findings back to the population of all Medicare patients with one of our study diseases, and did sensitivity analyses to see how much this reweighting affected our results. In all cases we examined that involved our major results, the weighted and unweighted results differed little. We therefore reported unweighted findings unless otherwise noted.

To handle pre- and post-PPS periods by disease interactions, we fit analysis of variance models in which disease was an explicit factor and interacted disease with the pre- and post-PPS effect. When the interactions were large, i.e., when there was serious disagreement among our diseases in the size of the difference between periods, we emphasized disease-specific summaries in our written findings, instead of drawing the reader's attention to across-disease PPS effects. When the differences by disease interactions were small to moderate, we conservatively reported the significance of the pre- and post-PPS effect by adjusting its significance in a manner consistent with the size of the interaction (Scheffe, 1959). We did this by computing the t-statistics for the pre- and post-PPS difference separately for each disease, averaging these t-statistics, and adjusting the average t-value by a multiplier that depended on the standard deviation, s, of the t-statistics. This multiplier went down as s went up, so that our combined t-statistic became more conservative (closer to 0) as the between-disease variation in the PPS effect increased.

CALCULATIONS OF STANDARD ERRORS FOR NATIONALLY REWEIGHTED ESTIMATES

We computed the standard errors for the nationally reweighted estimates in a standard way using national prevalences in the stratification grid described in Sec. II. The weights are fixed rather than random, and one may simply use weighted least squares in the usual way, as follows.

Instead of estimating β in the model $Y = \beta + e$ by

$$\hat{\beta} = (X^T X)^{-1} X^T Y \quad ,$$

we constructed a weight matrix W and used

$$\hat{\beta}_w = (X^T W X)^{-1} X^T W Y \quad .$$

This vector of estimates has covariance matrix

$$\Sigma_{\hat{\beta}_w} = \sigma^2 (X^T W X)^{-1} \quad ,$$

from which standard errors of any linear functions $c^T \hat{\beta}_w$ of the parameter estimates (such as the difference between pre-PPS and post-PPS 30-day mortality rates, adjusted for sickness at admission) were routinely computable from

$$V(c^T \hat{\beta}_w) = c^T \sigma_{\hat{\beta}w} c \quad .$$

(See any standard text on regression, e.g., Weisberg, 1985; or Draper and Smith, 1981). The particular implementation of this idea we used was the one in the interactive statistics package issued by Computing Resource Center, 1989.

DEMOGRAPHIC CHARACTERISTICS OF STUDY PATIENTS FOR PRE- AND POST-PPS SAMPLE COMBINED

Table A.18 shows the demographic characteristics of patients for five study diseases for the pre- and post-PPS sample combined. Table A.19 compares demographic characteristics for patients in the pre-PPS versus post-PPS periods.

Table A.18

SAMPLED PATIENT DEMOGRAPHICS FOR FIVE DISEASES (PRE- AND POST-PPS COMBINED)

	CHF n=2824	AMI n=2853	PNE n=2749	CVA n=2824	HIP n=2762
Age					
65-74	35	48	35	34	20
75-84	42	40	41	43	43
85-94	20	12	22	20	32
>= 95	3	1	3	2	4
Mean age (years)	78	76	79	79	82
Median age (age)	78	75	78	78	82
Male	44	52	51	44	22
Medicaid	18	14	21	15	17
Race					
American Indian/Alaskan Native	0	0	0	0	0
Asian/Pacific Islander	1	1	1	1	1
Black, not Hispanic	13	8	9	12	6
Hispanic	7	6	7	7	4
White, not Hispanic	75	81	79	77	85
Suspect Hispanic	0	0	0	0	0
Other	0	0	0	0	0
No Data	4	4	4	4	4
Preadmission residence					
Home alone	19	16	11	17	23
Home with others	51	54	47	56	37
Home, unspecified	14	17	12	10	12
Nursing home (1)	8	4	24	11	21
Retirement home (2)	2	1	3	3	5
Psychiatric facility or mental hospital	0	0	0	0	0
Chronic disease hospital	0	0	0	0	0
Rehabilitation hospital	0	0	0	0	0
Other	0	0	0	0	0
No Data	6	6	3	3	2
Discharge destination (3)					
Home	80	80	70	51	38
Nursing home (1)	13	6	24	32	53
Retirement home (2)	2	1	2	1	3
Psychiatric facility or mental hospital	0	0	0	0	0
Chronic disease hospital	0	0	0	0	0
Rehabilitation hospital	0	0	0	7	4
Acute care hospital	2	9	2	4	1
Other	0	0	0	3	0
No Data	2	3	2	1	0

(1) Nursing home includes Skilled Nursing Facility (SNF), Intermediate Nursing Facility (INF), Extended Care Facility (ECF), and nursing home, unspecified.

(2) Retirement home includes sheltered housing, congregate housing, halfway house, and board and care facility.

(3) Only for patients discharged alive.

Table A.19

SAMPLED PATIENT DEMOGRAPHICS FOR FIVE DISEASES (PRE- VS POST-PPS)

	CHF		AMI		PNE		CVA		HIP	
	Pre (n=1359)	Post (n=1465)	Pre (n=1416)	Post (n=1437)	Pre (n=1341)	Post (n=1408)	Pre (n=1379)	Post (n=1445)	Pre (n=1358)	Post (n=1404)
Age										
65-74	36	34	50	46	35	34	34	35	20	21
75-84	41	43	39	40	42	39	44	43	43	44
85-94	20	20	10	13	20	23	20	20	33	30
>= 95	3	3	1	1	3	3	2	3	4	5
Mean age (years)	78	79	75	76	78	79	78	78	82	81
Median age (years)	78	78	75	75	78	78	78	78	82	82
Male	43	45	53	50	51	50	45	43	21	24
Medicaid	18	17	14	14	21	21	16	15	18	17
Race										
American Indian/Alaskan Native	0	0	0	0	0	0	0	0	0	0
Asian/Pacific Islander	0	1	0	1	1	1	1	1	1	1
Black, not Hispanic	14	13	8	9	8	10	12	12	6	6
Hispanic	6	8	6	6	7	8	6	7	4	5
White, not Hispanic	74	76	81	81	79	78	76	77	85	86
Suspect Hispanic	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
No Data	5	3	5	3	5	3	5	2	4	3
Preadmission residence										
Home alone	18	20	14	17	10	12	17	18	22	23
Home with others	50	53	54	54	48	46	55	56	34	40
Home, unspecified	16	12	18	16	13	11	11	9	13	10
Nursing home (1)	7	8	4	5	22	25	12	11	24	19
Retirement home (2)	1	2	1	1	2	3	2	3	4	5
Psychiatric facility or mental hospital	0	0	0	0	0	0	0	0	0	0
Chronic disease hospital	0	0	0	0	0	0	0	0	0	0
Rehabilitation hospital	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
No Data	8	5	8	6	4	2	3	3	3	2
Discharge destination (3)										
Home	81	80	82	78	73	66	53	50	40	37
Nursing home (1)	11	14	6	7	20	28	32	32	53	54
Retirement home (2)	1	3	1	1	2	2	1	2	3	3
Psychiatric facility or mental hospital	0	0	0	0	0	0	0	0	0	0
Chronic disease hospital	0	0	0	0	0	0	0	0	0	0
Rehabilitation hospital	0	0	0	0	0	0	6	8	3	6
Acute care hospital	2	2	7	10	2	2	5	3	1	0
Other	0	0	0	0	0	0	2	4	0	1
No Data	4	1	4	3	3	1	2	1	1	0

(1) Nursing home includes Skilled Nursing Facility (SNF), Intermediate Nursing Facility (INF), Extended Care Facility (ECF), and nursing home, unspecified.

(2) Retirement home includes sheltered housing, congregate housing, halfway house, and board and care facility.

(3) Only for patients discharged alive.

Appendix B

DEVELOPING AND COLLECTING SICKNESS-AT-ADMISSION VARIABLES

This appendix provides additional documentation about the methods used for measuring sickness at admission (complexity), presents data about the distribution of patients in the sample by sickness-at-admission variables for the pre- and post-PPS sample combined, and presents data about the distribution of patients in the sample by sickness-at-admission variables for the pre-PPS versus post-PPS samples.

To use mortality and other clinical outcomes as a meaningful proxy for hospital quality, we must know the patient's sickness at admission (complexity) before the delivery of inhospital care. Outcomes can then be adjusted for sickness at admission. We used literature reviews, clinical judgment, and consensus panels to identify variables that have been found in clinical studies to predict outcomes. We pilot-tested the variables to see whether they were likely to be reported consistently during both the pre- and post-PPS period. We finally abstracted patient characteristics that were likely to predict outcomes, were sufficiently frequent to be worth collecting from the medical record, and were likely to be recorded consistently during both the pre- and post-PPS period.

To use the multiple dimensions of clinical care to study sickness at admission, the data base must be an accurate and valid representation of patient characteristics at admission. There are three main ways to collect this kind of data: from routine billing information, through prospective data collection at the time of admission, and from the medical record. From billing data age, sex, and diagnostic categories are available, but this information is usually not sufficient to provide an adequate adjustment for the effect of complexity on outcome. Prospective data collection can make use of a patient interview or a checklist completed by the physician and put into the medical record. Unfortunately, such techniques cannot be used to describe past hospital performance, and they are not currently feasible for use in all hospitals (Kahn et al., 1988a).

We used medical record review because it is currently the most feasible system for collecting sickness-at-admission data across time periods and hospitals. We were guided in our collection of these data from the medical record by seven basic principles.

First, for most variables describing sickness at admission, multiple data sources within the medical record needed to be reviewed (i.e., physicians' notes, nurses' notes, X-ray reports, laboratory results, electrocardiograms, and pathology findings). For example, to recognize whether the patient is immunocompromised, the patient's history was examined for use of the word *immunocompromise*, for diagnostic equivalents (e.g., metastatic cancer), and for immunocompromising drugs (e.g., chemotherapy or steroids). Review of the physical examination provided evidence about cachexia, debilitation, or thenar wasting, and review of laboratory reports provided information about white blood counts and albumin values. For each sickness-at-admission variable, a precise clinical definition was developed.

Second, we took great efforts to avoid both overstating the admission level of patients with multiple descriptions of illness and understating the admission sickness level of patients with only a single description. For example, some records described patients as sick according to a number of factors (e.g., history, diagnoses, use of medications, physical examination, and/or laboratory data); other records used only one term to describe an equally sick patient. We developed reasonable criteria for data collection to allow us to identify patients with similar sickness levels, despite more or less information in the record.

Third, we paid careful attention to medical dialects and recording practices used in different segments of the study sample. Since the study used data from different time periods, we expected differences in recording, because incentives for recording have changed over time. Different settings, such as teaching compared with nonteaching hospitals, were also considered because they use different vocabularies. We used a pilot study of medical records to test variables for consistent patterns of recording before and after PPS implementation.

Fourth, we used special care when employing reports of data rather than the raw data itself. This was especially important when using reports of radiographic studies. Review of the medical record allows access only to the radiologists' (and/or clinicians') reports rather than the X-rays themselves. Although this problem is more relevant to recorded than to direct patient data, there is a less standardized format for reporting disease criteria in the X-ray reports than elsewhere. Because X-rays may provide valuable information about patient sickness at admission (e.g., presence of congestive heart failure or pulmonary edema for patients hospitalized with acute myocardial infarction, pneumonia, or cerebrovascular accident; or presence of infarct, hemorrhage, or increased intracranial pressure for patients hospitalized with cerebrovascular accident), it was important to develop a valid system for grading severity of X-ray findings.

Fifth, an approach was developed for interpreting unrecorded or missing data. For example, in the admission history and physical, physicians customarily report all important positive historical and physical findings, but only pertinent negative findings. This meant that abstraction from the medical record of many clinical characteristics present at the time of admission could identify the presence of a clinical problem but could not distinguish the absence of the condition from the situation where no data were found in the record about the presence or absence of the problem. Under these circumstances a bias could result if sickness-at-admission variables are not carefully selected, because a hospital with detailed recording practices might appear to have sicker patients than a hospital with less comprehensive ones.

To reduce the likelihood of bias, we attempted to include only measures of sickness at admission from the medical record that generally would be recorded if the patient had the pathology in question. Following this rule, in most instances, it would be possible to assign normal values or no comorbidity if specific data were absent. For example, if there is no report about dementia, the patient can be considered to have normal mental status. We tested these decisions during the analysis phase by comparing whether patients with missing data were more or less likely to die or suffer some other adverse outcome than are patients without missing data. After carefully selecting variables that would not likely be subject to a recording bias, we assumed that no mention of a variable relating to acute and chronic conditions and functional capabilities was the same as no pathology or normal function. When patients with missing data had higher mortality rates than patients with data, we made adjustments during the study analysis.

Sixth, just as a choice needs to be made in studies such as ours between disease-specific compared with nonspecific sampling, a choice needs to be made regarding the use of a generic measure of sickness at admission or a disease-specific measure. Although APACHE II APS, which uses the same items and the same weights to determine sickness levels across diseases, has been shown to account for a noticeable amount of the variability in hospital outcomes, clinical principles suggest that such a generic measure should be supplemented with various disease-specific items and disease-specific weights. Thus, we developed disease-specific measures to supplement APACHE II APS variables.

Seventh, it is critical in measuring sickness levels to distinguish sickness with which patients present at admission from sickness affected by inhospital processes and outcomes. To accomplish this, we used only data from the initial assessment as sickness-at-admission variables. For vital signs, we collected both the first and worst value for the day of admission but in analysis used only first values. We used the worst laboratory values on day 1, since the medical record does not reliably document timing of laboratory studies. Most patients, however, had only one of each type of laboratory test on each day. If there were no laboratory values for a particular variable on day 1, values from day 2 of the hospital stay were acceptable.

For this PPS study, in which data were collected retrospectively from the medical record, we altered some of the definitions of the variables used by George Washington University (developers of the APACHE II system). Table B.1 documents the differences between RAND's variable definitions and those of George Washington University.[1]

Table B.2 shows the distribution of APACHE II APS variables for five diseases in the pre- and post-PPS sample combined. The codes refer to variable categories used in the PPS data set. The scores refer to the number of points assigned for patient values in each category. The scores presented were developed by Knaus et al. (1985).

Table B.3 shows the distribution of patients by RAND Acute Complexity (sickness-at-admission) variables for the pre- and post-PPS sample combined. These disease-specific lists of variables are designed to measure acute morbid and comorbid conditions present at the time of hospital admission. Abbreviation used in Table B.3 are listed below:

AF	Atrial fibrillation
CXR.CHF	Chest X-ray description of congestive heart failure
CXR.PNE	Chest X-ray description of pneumonia
CPK.HNV	Highest normal value for CPK at the patient's laboratory
D1H	Day 1 of hospitalization
D2H	Day 2 of hospitalization
HNV	Highest normal value for CPK at the patient's laboratory
PAC	Premature atrial contraction
Pre op	Pre-operative
V-tach	Ventricular tachycardia

Table B.4 shows the distribution of patients by RAND Chronic Complexity (sickness-at-admission) variables for the pre- and post-PPS sample combined. The disease-specific lists of variables are designed to measure chronic morbid and comorbid conditions present at the time of hospital admission. Abbreviations used in Table B.4 are listed below:

CABS	Coronary artery bypass surgery
Chemo	Chemotherapy
Dx	Diagnosis
Dx-hip cancer	Diagnosis of hip cancer

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[1] Personal communication with researchers from George Washington, 1987.

Table B.1

DOCUMENTATION OF DIFFERENCES IN APACHE II APS VARIABLES USED BY GEORGE WASHINGTON UNIVERSITY AND RAND

	George Washington University	RAND
Timing	Worst value in first 24 hours	First value on hospital day 1 or 2 (for Na, K, Cr, HCT, WBC, HC03, if more than one value is recorded per day, the most deviant is used)
Variable		
Temperature	Rectal temperature, if possible	Any temperature
Mean blood pressure (DBP × 2 + SBP)/3		If DBP is missing: if SBP >= 110, (SBP × 2)/3 if SBP < 110, (SBP)/3
Heart Rate	---	---
Respiratory Rate	---	---
Oxygenation (p02 or A-aD02)		If FI02 is missing, use p02
pH	---	---
Bicarbonate (HC03)	---	---
Sodium (Na)	---	---
Potassium (K)	---	---
Creatinine (Cr)	Double the number of points for acute renal failure	No doubling of points because cannot reliably determine if renal failure is acute. BUN is substituted for missing Cr values
Hematocrit (HCT)		Substitute "hemoglobin × 3" for missing HCT values
WBC	---	---
Nerologic Points	15 - Glasgow Coma Score (GCS): GCS based on sum of best eye opening, motor, and verbal responses (the better the response, the higher the score)	Coma.MD = 9 pts Neuro change.MD or RN AND/OR Confusion.MD or RN = 5 pts

Table B.2

DISTRIBUTION OF APACHE II APS VARIABLES FOR FIVE DISEASES
(Pre- and Post-PPS Sample Combined)

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	Code	Score	CHF (n=2824)	AMI (n=2853)	PNE (n=2749)	CVA (n=2824)	HIP (n=2762)
			(% of patients)				
APACHE Temperature							
C < = 29.9	1	4	0.0	0.0	0.0	0.0	0.0
C = 30-31.9	2	3	0.0	0.0	0.1	0.0	0.0
C = 32-33.9	3	2	0.2	0.2	0.1	0.1	0.0
C = 34-35.9	4	1	18.7	20.0	5.6	13.5	10.1
C = 36-38.4	5	0	79.2	77.3	70.6	83.4	89.2
C = 38.5-38.9	6	1	0.8	0.5	11.5	1.4	0.2
C = 39-40.9	7	3	0.6	0.2	11.9	1.1	0.3
C > = 41	8	4	0.0	0.0	0.1	0.1	0.0
Missing	M	-	0.5	1.8	0.1	0.4	0.1
APACHE Mean Blood Pressure (MPB)							
MBP < = 49	1	4	0.4	2.7	1.4	0.6	0.2
MBP = 50-69	2	2	1.9	3.0	6.7	1.4	1.0
MBP = 70-109	3	0	61.0	55.1	74.9	46.0	61.1
MBP = 110-129	4	2	24.8	27.7	13.4	33.1	29.5
MBP = 130-159	5	3	10.6	10.0	3.3	16.4	7.6
MBP >= 160	6	4	1.2	1.0	0.1	2.3	0.5
Missing	M	-	0.2	0.5	0.1	0.3	0.0
APACHE Heart Rate (HR)							
HR < = 39	1	4	0.1	0.7	0.0	0.1	0.1
HR = 40-54	2	3	1.6	4.2	0.4	2.0	0.4
HR = 55-69	3	2	10.4	17.7	6.1	17.7	12.2
HR = 70-109	4	0	65.5	59.7	68.5	71.0	82.3
HR = 110-139	5	2	17.5	13.4	21.0	7.6	4.8
HR = 140-179	6	3	4.3	3.5	3.7	1.3	0.2
HR > = 180	7	4	0.4	0.2	0.2	0.0	0.0
Missing	M	-	0.1	0.5	0.1	0.3	0.0
APACHE Respiratory Rate (RR)							
RR < = 5	1	4	0.1	0.4	0.1	0.2	0.0
RR = 6-9	2	2	0.0	0.1	0.1	0.2	0.0
RR = 10-11	3	1	0.0	0.4	0.1	0.4	0.1
RR = 12-24	4	0	53.6	75.0	53.5	83.6	92.3
RR = 25-34	5	1	30.9	16.1	28.0	11.5	6.5
RR = 35-49	6	3	14.2	7.0	17.0	3.4	0.9
RR > = 50	7	4	0.8	0.4	1.2	0.1	0.1
Missing	M	-	0.4	0.7	0.1	0.5	0.1
APACHE pH							
pH < 7.15	1	4	1.7	3.1	0.9	0.7	0.0
pH = 7.15-7.24	2	3	2.8	2.7	1.6	0.8	0.2
pH = 7.25-7.32	3	2	4.7	4.3	3.2	1.7	0.4
pH = 7.33-7.49	4	0	42.0	34.1	44.2	24.8	14.2
pH = 7.5-7.59	5	1	5.9	4.0	7.5	2.1	1.9
pH = 7.6-7.69	6	3	0.1	0.7	0.1	0.2	0.1
pH > = 7.7	7	4	0.0	0.1	0.0	0.0	0.0
Missing	M	-	42.7	51.1	42.5	69.7	83.1

Table B.2 continued

DISTRIBUTION OF APACHE II APS VARIABLES FOR FIVE DISEASES
(Pre- and Post-PPS Sample Combined)

	Code	Score	CHF (n=2824)	AMI (n=2853)	PNE (n=2749)	CVA (n=2824)	HIP (n=2762)
				(% of patients)			
APACHE Hematocrit (HCT)							
HCT or (Hgbx3) < 20	1	4	0.7	0.2	0.3	0.1	0.2
HCT or (Hgbx3) = 20-29.9	2	2	6.6	2.9	6.1	2.4	8.5
HCT or (Hgbx3) = 30-45.9	3	0	75.6	76.9	82.5	77.5	85.1
HCT or (Hgbx3) = 46-49.9	4	1	7.2	12.2	6.6	10.9	2.2
HCT or (Hgbx3) = 50-59.9	5	2	2.5	3.2	2.6	3.4	0.5
HCT or (Hgbx3) > = 60	6	4	0.1	0.0	0.0	0.2	0.0
Missing	M	-	7.2	4.5	1.8	5.5	3.5
Hgb used if no HCT							
APACHE White Blood Cell Count (WBC)							
WBC < 1	1	4	0.0	0.0	0.2	0.0	0.0
WBC = 1-2.9	2	2	0.4	0.1	1.2	0.3	0.1
WBC = 3-14.9	3	0	83.5	82.8	63.0	85.3	82.9
WBC = 15-19.9	4	1	6.0	9.0	19.1	6.5	10.4
WBC = 20-39.9	5	2	2.6	3.3	14.0	2.3	2.8
WBC > = 40	6	4	0.2	0.1	0.8	0.2	0.1
Missing	M	-	7.3	4.7	1.7	5.4	3.7
APACHE Coma Scale							
Coma	1	9	1.2	4.0	5.9	22.7	--
Confusion (MD or RN) and Neuro change (MD or RN)	2	5	6.2	26.9	14.8	13.1	9.3
Neuro change (MD or RN) only	3	5	9.7	0.0	13.0	12.1	4.3
Confusion (MD or RN) only	4	5	8.7	0.0	12.0	17.6	22.1
No Neurologic deficit	0	0	74.1	69.1	54.4	34.4	64.3
APACHE Venous Bicarbonate (HCO3)							
HCO3 < 15	1	4	0.9	1.1	0.9	0.6	--
HCO3 = 15-17.9	2	3	1.9	2.5	1.5	1.0	--
HCO3 = 18-21.9	3	2	8.2	9.2	6.1	7.0	--
HCO3 = 22-31.9	4	0	58.7	66.3	60.3	66.1	--
HCO3 = 32-40.9	5	1	12.9	5.3	10.7	7.3	--
HCO3 = 41-51.9	6	3	0.7	0.1	0.7	0.1	--
HCO3 > = 52	7	4	0.0	0.0	0.0	0.0	--
Missing	M	-	16.6	15.5	19.9	17.8	--

Table B.2 continued

DISTRIBUTION OF APACHE II APS VARIABLES FOR FIVE DISEASES
(Pre- and Post-PPS Sample Combined)

	Code	Score	CHF (n=2824)	AMI (n=2853)	PNE (n=2749)	CVA (n=2824)	HIP (n=2762)
			(% of patients)				
APACHE Oxygen							
p02 < 55	1	4	12.1	6.4	17.5	2.5	2.7
p02 = 55-60	2	3	6.8	3.2	10.6	2.2	2.2
p02 = 61-70	3	1	11.5	7.5	13.8	5.7	5.1
p02 > 70	4	0	25.6	27.7	14.3	18.2	6.5
AaD02 < 200	5	0	0.1	0.4	0.0	0.4	0.0
AaD02 = 200-349	6	2	0.3	0.9	0.4	0.4	0.1
Aa002 = 350-499	7	3	0.2	0.8	0.1	0.3	0.0
AaD02 > = 500	8	4	0.8	1.9	0.7	0.6	0.1
Missing	M	-	42.6	51.1	42.5	69.7	83.2
If FL02 > = 50, Aa002 = (FL02(713) - pC0 2 - p02) is used							
APACHE Sodium (Na)							
Na < = 110	1	4	0.1	0.1	0.1	0.0	0.0
Na = 111-119	2	3	0.7	0.2	0.7	0.2	0.2
Na = 120-129	3	2	4.6	3.9	6.4	2.8	4.5
Na = 130-149	4	0	88.7	88.6	79.0	86.3	84.7
Na = 150-154	5	1	0.6	0.6	1.8	0.8	0.4
Na = 155-159	6	2	0.0	0.1	0.9	0.3	0.0
Na = 160-179	7	3	0.1	0.1	0.9	0.5	0.1
Na > = 180	8	4	0.0	0.0	0.0	0.0	0.0
Missing	M	-	5.2	6.5	10.2	8.9	10.1
APACHE Potassium (K)							
K < 2.5	1	4	0.6	0.2	0.3	0.5	0.3
K = 2.5-2.9	2	2	1.9	2.7	3.0	3.0	2.8
K = 3.0-3.4	3	1	9.3	11.7	10.4	13.7	10.8
K = 3.5-5.4	4	0	79.0	76.7	73.1	72.7	75.6
K = 5.5-5.9	5	1	2.8	1.6	2.3	0.9	1.0
K = 6.0-6.9	6	3	1.5	1.1	0.8	0.6	0.3
K > = 7.0	7	4	0.2	0.1	0.1	0.0	0.1
Missing	M	-	4.7	6.0	9.9	8.7	9.1
APACHE Creatinine (Cr)							
Cr < 0.6	1	2	0.2	0.2	1.0	0.5	1.3
Cr = 0.6-1.4	2	0	40.9	47.1	47.6	50.9	53.9
Cr = 1.5-1.9	3	2	17.9	15.1	13.1	12.8	6.9
Cr = 2.0-3.4	4	3	13.0	7.7	7.9	5.3	2.8
Cr > = 3.5	5	4	3.2	1.9	2.3	1.3	0.7
BUN = < 10	6	2	0.5	0.4	0.9	0.7	1.2
BUN = 10-20	7	0	6.5	10.4	8.2	10.3	11.7
BUN = 21-80	8	1	9.1	7.5	7.3	7.5	9.5
BUN = 81-100	9	2	0.0	0.0	0.1	0.1	0.0
BUN = 101-150	10	3	0.1	0.0	0.1	0.1	0.0
BUN > 150	11	4	0.0	0.0	0.0	0.0	0.0
Missing	M	-	8.5	9.4	11.4	10.4	12.1
BUN is used if no Creatinine							

Table B.3

Distribution of RAND Acute Complexity Variables (Pre- and Post-PPS Sample Combined)

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	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Arrest in ER	0.7	----	----	----	----
Arrest or intubation in ER	----	----	2.3	3.4	0.1
Arrest within 24 hrs prior to admission	----	3.0	----	----	----
Intubation D1H	2.4	7.8	4.0	4.2	----
CXR.CHF: Severe	16.0	7.7	3.1	1.7	0.5
Moderate	33.3	8.6	4.0	2.9	0.7
Mild	28.8	16.8	19.5	11.5	7.5
Unlikely or no CHF	17.0	52.6	70.8	63.5	84.0
no CXR	4.9	14.4	2.5	20.4	7.2
CXR.PNE: Unilat. PNE	4.3	----	42.6	2.9	1.5
Unilat.infiltrate	4.5	----	18.1	2.4	1.9
Bilat.PNE or infiltrate/No CHF	1.4	----	17.6	1.0	0.8
Bilat.PNE or infiltrate/CHF	6.8	----	6.3	0.7	0.4
Unlikely PNE or infiltrate	8.9	----	7.1	7.4	6.3
No evidence	69.2	----	5.7	65.2	82.0
No CXR	4.9	----	2.5	20.4	7.2
Cardiac Enzymes (CPK) at admission:					
CPK value > CPK.HNV x 3	1.7	50.9	2.1	3.3	----
CPK value > GPK.HNV x 1.5	2.8	15.9	1.7	2.6	----
CPK value > CPK.HNV x 1.0	3.3	6.3	2.0	3.0	----
CPK value <= CPK.HNV	45.0	21.6	22.1	25.0	----
Atrial Arrhythmias.EKG					
AF etc.	----	----	----	----	7.2
PACs	----	----	----	----	7.1
no atrial arrhythmias	----	----	----	----	77.2
no EKG	----	----	----	----	8.4
Ventricular arrhythmias.EKG					
V-tach	----	----	----	----	0.0
PVC's	----	----	----	----	8.4
no ventricular arrhythmias	----	----	----	----	83.2
no EKG	----	----	----	----	8.4
Heart block.EKG: 3rd degree	----	----	----	----	0.2
2nd degree	----	----	----	----	0.1
1st degree	----	----	----	----	7.8
sinus bradycardia	----	----	----	----	1.6
no rhythm disturbance	----	----	----	----	81.9
no EKG	----	----	----	----	8.4

Table B.3

Distribution of RAND Acute Complexity Variables
(Pre- and Post-PPS Sample Combined)

Page 2 of 3

	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Angina within 1 week prior	5.9	----	----	0.8	----
CHF within 1 week prior	----	----	----	1.6	----
Digitalis level at admission					
Highest dig level > 2.2	4.1	----	----	----	0.3
Highest dig level <= 2.2	37.4	----	----	----	5.6
No dig level at admission	58.5	----	----	----	94.1
SGOT at admission					
SGOT >= 80	6.2	24.2	5.4	2.6	2.1
SGOT = 40-79	14.3	20.4	12.3	9.7	8.1
SGOT < 40	55.5	42.3	51.5	60.0	54.7
no SGOT at admission	23.9	13.1	30.8	27.7	34.9
Bilirubin at admission					
Bilirubin >= 4	0.8	0.6	0.6	0.1	0.3
Bilirubin = 2-3.9	3.7	0.9	1.9	1.0	1.1
Bilirubin = 1.2-1.9	9.8	4.9	6.6	5.9	5.6
Bilirubin < 1.2	56.2	65.6	58.5	63.2	58.7
No Bilirubin at admission	29.6	28.0	32.4	29.7	34.1
Positive blood culture with fever on D1H or D2H	0.3	----	----	----	----
Positive blood culture or bacteremia/ sepsis D1H or D2H	----	----	8.8	----	----
Positive Urine culture D1H or D2H	----	----	10.9	----	----
Pre op confusion (regardless of dementia) D1H	----	----	----	----	35.7
Influenza within 2 weeks prior	----	----	3.8	----	----
Respiratory distress at admission	----	----	13.4	----	----
Wheezing at admission	----	----	22.8	----	----
Empyema at admission	----	----	0.3	----	----
Lung abscess at admission	----	----	0.4	----	----
Meningitis at admission	----	----	0.1	----	----
Pericarditis at admission	----	----	0.1	----	----
Endocarditis at admission	----	----	0.2	----	----
Prior antibiotics	----	----	23.4	----	----

Table B.3

Distribution of RAND Acute Complexity Variables
(Pre- and Post-PPS Sample Combined)

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	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Fracture location					
Intertrochanteric	----	----	----	----	49.7
Femoral neck	----	----	----	----	46.7
Subtrochanteric	----	----	----	----	1.5
Other	----	----	----	----	2.0
No data	----	----	----	----	0.1
Fracture Stability					
Garden Stage: 1	----	----	----	----	0.5
2	----	----	----	----	0.6
3/4	----	----	----	----	3.1
No data/not applicable	----	----	----	----	95.8
Displaced fracture	----	----	----	----	52.0
Comminuted fracture	----	----	----	----	31.6
Impacted fracture	----	----	----	----	19.4
Stable fracture	----	----	----	----	1.2
Valgus fracture	----	----	----	----	3.9
Varus fracture	----	----	----	----	30.7
Speech deficit					
Aphasia	----	----	----	22.5	----
Not able to speak	----	----	----	6.8	----
Speaks with difficult	----	----	----	31.6	----
Deficit not described	----	----	----	0.3	----
No deficit	----	----	----	38.7	----
Motor deficit	----	----	----	86.9	----
Coma scale					
Decorticate, decerebrate.MD	----	----	----	3.0	----
No response to pain.MD	----	----	----	4.5	----
Coma.MD and Coma.RN	----	----	----	7.9	----
Coma.MD or Coma.RN	----	----	----	10.7	----
Neurochange.MD or Neuro Change.RN. or unable to follow commands.MD	----	----	----	24.9	----
Confused.MD or confused.RN	----	----	----	15.9	----
No deficit	----	----	----	33.2	----
Face deficit	----	----	----	49.3	----
Visual deficit	----	----	----	39.6	----
Sensory deficit of limbs	----	----	----	21.2	----
Seizure	----	----	----	5.6	----
Type of CVA					
Hemorrhage	----	----	----	10.6	----
Lacunar	----	----	----	5.7	----
Increased intracranial pressure	----	----	----	6.6	----

Table B.4

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Distribution of RAND Chronic Complexity Variables (Pre- and Post-PPS Sample Combined)

	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Prior valvular disease	11.7	3.4	----	4.1	2.9
Critical Aortic Stenosis	----	----	----	----	0.4
Prior Angina	16.7	29.5	----	8.4	7.1
Prior Chest pain unknown origin	7.7	15.9	----	3.0	----
Prior MI: time unspecified	----	30.8	----	----	----
Prior MI: <=3 months	----	----	----	----	0.4
4-6 months	----	----	----	----	0.1
>=7 months	----	----	----	----	17.4
Prior MI: <=3 months	3.4	----	----	0.7	----
>=4 months	21.7	----	----	12.3	----
Prior pacemaker	10.3	2.6	----	3.8	2.0
Prior CHF	----	----	----	16.6	----
RAND prior CHF (1)	77.4	29.7	20.6	----	21.0
Prior hypertension	36.8	44.3	----	52.2	----
Prior Angioplasty	----	0.4	----	----	----
Prior CABS	----	3.8	----	----	----
Prior Angioplasty or CABS	3.5	----	----	1.4	----
Prior valvular disease/ angina/Mi/pacemaker/PCTA/ CABS	----	----	20.8	----	----
Prior Atrial Fibrillation	----	----	----	12.6	----
Prior Arrhythmia, excluding Atrial Fib	----	----	----	8.5	----
Prior Arrhythmia, including Atrial Fib	----	----	13.4	----	9.9

Table B.4

Distribution of RAND Chronic Complexity Variables (Pre- and Post-PPS Sample Combined)

	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Non-compliance	13.1	----	----	----	----
Prior Beta-Blocker	8.2	----	----	----	----
Prior Left Ventricular Depressant	3.9	----	----	----	----
RAND Prior Pharmacologic CHF	23.7	----	----	----	----
Prior Antiarrhythmics	16.0	----	----	----	----
Prior Cancer					
Poor prognosis cancer	N.A.	0.7	1.2	0.8	1.0
Cancer, chemo or radiation Rx	N.A.	1.0	2.0	1.3	1.7
Cancer, hormone Rx	0.2	0.1	0.4	0.2	0.0
Cancer, no evidence of activity	8.0	6.0	7.3	5.9	8.2
Immunocompromised	----	----	2.4	0.3	----
Prior Cirrhosis	1.5	0.4	1.1	0.5	1.2
Prior Diabetes	----	23.6	13.4	23.8	----
RAND Prior Diabetes (2)	25.1	----	----	----	11.4
Prior CVA	10.2	9.3	13.1	34.7	10.5
RAND prior chronic renal failure	2.7	0.2	0.1	0.6	0.3
Prior COPD	22.7	12.7	31.3	11.8	12.5
Prior Home 02	2.4	0.5	5.7	----	0.6
Pneumonectomy	----	----	0.9	----	0.4
Prior aspiration/ dysphagia/etc	----	----	4.5	----	----
Prior thoracic/abdominal surgery (<=1 month)	----	----	0.6	----	----
Prior neuromuscular disease of the thorax	----	----	0.4	----	----
Multiple myeloma	----	----	0.7	----	----

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Table B.4

Distribution of RAND Chronic Complexity Variables
(Pre- and Post-PPS Sample Combined)

	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Splenectomy	----	----	0.3	----	----
Respiratory Failure	----	----	2.2	----	----
Interstitial lung disease	----	----	3.0	----	----
Tracheostomy	----	----	0.6	----	----
Prior Aminophylline	----	----	14.4	----	----
New Lung cancer diagnosis	----	----	0.9	----	----
Prior Hospitalization					
<=1 month	----	----	15.8	----	----
<=6 months	34.7	----	----	18.8	13.7
for pulmonary disease	----	----	22.3	----	----
Prior Arterial Disease	2.9	2.5	----	3.2	----
Prior psychosis or depression	4.5	2.7	----	4.5	5.1
Difficulty with limbs	9.6	6.8	----	----	----
Prior Deep vein thrombosis	----	----	----	1.0	----
Prior deep vein thrombosis or pulmonary embolism	----	----	----	----	1.0
Prior dementia					
Severe	1.5	0.5	4.8	2.7	5.5
Less severe	9.0	4.2	16.1	12.1	19.8
Current Smoker	9.7	13.7	12.6	8.8	----
Current Alcoholism	----	----	2.8	2.5	----
Prior Steroids	2.5	----	6.5	2.0	3.5
Albumin level or malnourished (3)					
Albumin < 2.5	1.1 (1.1)	0.5 (0.5)	3.5 (3.5)	0.6 (0.6)	0.5 (0.5)
Albumin = 2.5-3.0	6.3 (6.3)	2.5 (2.5)	15.4 (15.4)	4.0 (4.0)	5.3 (5.3)
Malnourished (albumin missing or > 3.0)	---- ----	---- ----	10.0 (10.0)	----	4.9 (4.9)
Albumin > 3.0	60.6 (92.6)	66.9 (97.0)	41.9 (71.1)	63.2 (95.3)	54.9 (89.3)
No data	32.0	30.1	29.2	32.1	34.4

Table B.4

Distribution of RAND Chronic Complexity Variables
(Pre- and Post-PPS Sample Combined)

	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Malnourished	----	----	----	4.8	----
Nasogastric (NG) tube on day 1	----	----	----	5.9	----
NG tube prior to admission	----	----	3.3	----	----
Morbid Obesity	----	----	0.3	0.7	----
ESR					
ESR > 60	----	----	----	2.0	----
ESR <=60	----	----	----	14.7	----
No ESR test	----	----	----	83.3	----
Prior Anticoagulants	----	----	----	3,2	----
Prior Temporal Arteritis	----	----	----	0.1	----
Prior Lupus	----	----	----	0.8	----
Prior Carotid endarterectomy	----	----	----	2.3	----
Parkinson's Disease	----	----	----	----	3.7
Paget's Disease	----	----	----	----	0.6
Osteoarthritis	----	----	----	----	7.1
Rheumatoid Arthritis	----	----	----	----	0.1
New Dx-hip cancer (made during hospitalization)	----	----	----	----	0.4
Osteoporosis	----	----	----	----	23.0
Stress Fracture	----	----	----	----	0.1
Osteoporosis or stress fracture	----	----	----	----	23.0
Prior fracture--opposite hip	----	----	----	----	11.0
Urinary continence (3)					
Incontinent	11.2 (11.2)	----	22.8 (22.8)	16.0 (16.0)	16.0 (16.0)
Continent	57.5 (88.8)	----	48.0 (77.2)	48.2 (84.0)	49.5 (83.9)
No data	31.3	----	29.2	35.8	34.4

Table B.4

Distribution of RAND Chronic Complexity Variables
(Pre- and Post-PPS Sample Combined)

	CHF % of Patients (n=2824)	AMI % of Patients (n=2853)	PNE % of Patients (n=2749)	CVA % of Patients (n=2824)	HIP % of Patients (n=2762)
Ambulatory status (3)					
Unable to walk	4.5(4.5)	----	14.7(14.7)	7.2(7.2)	4.1(4.1)
Walks with assistance	17.0(17.0)	----	15.0(15.0)	16.5(16.5)	21.9(21.9)
Probably able to walk	53.2(78.5)	----	43.8(70.4)	53.0(76.3)	62.3(74.0)
No data	25.3	----	26.6	23.3	11.7
Preadmission residence					
Home alone	18.7	15.9	10.9	17.2	22.7
Home with others	51.3	53.9	46.7	55.5	36.9
Home unspecified	13.8	16.9	12.3	10.1	11.5
Nursing home	7.9	4.4	23.5	11.4	21.4
Retirement home	1.8	1.3	2.6	2.7	4.6
Mental hospital	0.1	0.0	0.3	0.0	0.4
Chronic disease	0.0	0.0	0.0	0.0	0.0
Rehab hospital	0.1	0.0	0.3	0.1	0.0
Other	----	0.2	----	0.1	----
No data	6.2	7.4	3.4	2.8	2.5

(1) RAND Prior CHF includes mention of CHF or use of digitalis prior to admission.

(2) RAND Prior Diabetes includes mention of diabetes OR insulin prior to admission.

(3) Numbers in parentheses based on the assumption that patients with no data are normal.

Data Sources: CHF Complexity Scores-Dataset D4,19:01, August 9, 1988, NV
AMI Complexity Scores-Dataset , 0:13, February 15, 1989, JK
PNE Complexity Scores-Dataset G4,18:13, December 22, 1988, NV
CVA Complexity Scores-Dataset C4,18:00, January 17, 1989, NV
HIP Complexity Scores-Dataset E4,18:33, January 4, 1989, NV

ESR	Erythrocyte sedimentation rate
Fib	Fibrillation
02	Oxygen therapy
PCTA	Percutaneous Transluminal Angioplasty
Rx	Therapy

Table B.5 shows the distribution of patients by Body System variables for the pre- and post-PPS sample combined. The disease-specific definitions of each variable are listed in the table.

Table B.6 shows the distribution of patients by the number of body systems with sickness at admission for the pre- and post-PPS sample combined. Body system sickness at admission is defined in Table B.5. Both percentages and cumulative (cum) percentages are listed.

Table B.7 shows the distribution of patients by the variables used in the Norris Coronary Prognostic Index (Norris et al., 1969). The codes refer to variable categories used in the PPS data set. The scores refer to the number of points assigned for patient values in each category. The scores presented were developed by Norris. Electrocardiograms from day 1 of the hospitalization were used to assign location and extent of the infarct. If no day 1 electrocardiogram was available, the day 2 electrocardiograms were used. Abbreviations used in Table B.7 are listed below:

EKG: anterior	The EKG report suggests an anterior myocardial infarction
EKG: inferior	The EKG report suggests an inferior myocardial infarction
EKG: subendocardial	The EKG report suggests a subendocardial myocardial infarction
EKG: transmural but location unspecified	The EKG report suggests a transmural myocardial infarction with location unspecified
MD: anterior	Physician reads the EKG report as showing evidence for an anterior myocardial infarction
MD: anterior and inferior	Physician reads the EKG report as showing evidence for an acute and inferior myocardial infarction
MD: inferior	Physician reads the EKG report as showing evidence for an inferior myocardial infarction
MD: subendocardial	Physician reads the EKG report as suggesting a subendocardial myocardial infarction
MD: transmural but location unspecified	Physician reads the EKG report as showing evidence for a transmural myocardial infarction with location unspecified
MI location/extent	Location and extent of myocardial infarction as noted by physician review of the electrocardiogram

Table B.5

RAND BODY SYSTEM COUNT VARIABLES
(pre- and post-PPS sample combined)

	CHF		AMI		PNE		CVA		HIP	
	Variable Definition	(n=2824) Frequency %	Variable Definition	(n=2614) Frequency %	Variable Definition	(n=1941) Frequency %	Variable Definition	(n=2164) Frequency %	Variable Definition	(n=2039) Frequency %
1. Cardiac	All patients	100	All patients	100	Prior valvular disease/ angina/MI/pacemaker/ PTCA/CABS Prior CHF Prior Arrhythmias Pericarditis Endocarditis Prior Digitalis	44	Prior valvular disease Prior angina Prior MI Prior Pacemaker Prior CHF Prior PTCA/CABS Prior Hypertension Prior Atrial fibrillation Prior Other arrhythmias	72	Prior critical aortic stenosis (AS) Prior valvular disease angina/PTCA/CABS/aneurysm/ lower extremity bypass or amputation Prior MI Prior Arrhythmias Prior Pacemaker Prior CHF Prior Digitalis	34
2. Pulmonary	Prior COPD Prior Home O2 Current Smoker	28	Prior COPD Prior Home O2 Current Smoker	23	All Patients	100	Prior COPD Current smoker	18	Prior COPD Prior Home O2 Prior Pneumonectomy	13
3. Hepatobiliary	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	24	Prior cirrhosis Admission Bilirubin >= 2	2	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	20	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	13	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	12
4. Endocrine	Prior Diabetes Prior Insulin	25	Prior Diabetes	24	Prior Diabetes	13	Prior Diabetes	24	Prior Diabetes Prior Insulin	11
5. Arterial	Prior lower extremity bypass or amputation	3	Prior lower extremity bypass or amputation	2	No Data	--	Prior lower extremity bypass or amputation Prior carotid endarterectomy (CE) Prior Temporal arteritis	5	Prior Deep Vein Thrombosis (DVT) or pulmonary embolus (PE)	1
6. Renal	Prior chronic renal failure Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	11	Prior chronic dialysis/ kidney transplant Admission Creatinine >= 2.0 Admission BUN >= 101	10	Prior chronic dialysis/kidney transplant Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	30	Prior chronic/renal failure Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	21	Prior chronic dialysis/kidney transplant Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	19
7. Neurologic	Prior Dementia Prior CVA Coma at admission Confusion at admission Neurologic change at admission	35	Prior Dementia Prior CVA Coma at admission Confusion at admission Neurologic change at admission	37	Prior Dementia Prior CVA Coma at admission Confusion at admission Neurologic change at admission Prior neuromuscular disease of thorax Meningitis	51	All patients	100	Prior Dementia Prior CVA Parkinson's disease Confusion at admission Neurologic change at admission	47
8. Psychiatric	Prior Depression/Psychosis	4	Prior Depression/Psychosis	3	No Data	--	Prior Depression/Psychosis Current alcoholism	7	Prior Depression/Psychosis	5
9. Oncologic	Prior Cancer (1)	8	Prior Cancer	8	Prior Cancer Prior Multiple Myeloma	11	Prior Cancer	8	Prior Cancer	11
10. Immunologic	Prior Steroid Use	2	No Data	--	Prior Steroid Use Immunocompromised Prior Splenectomy	8	Prior Steroid Use Lupus Immunocompromised	2	Prior Steroid Use	4
11. Hematologic	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	10	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	6	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20 Admission % polys >= 90 Admission % bands >= 15	41	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	5	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	11
12. Musculoskeletal	Partially/totally nonambulatory Difficulty with limbs	26	Difficulty with limbs	7	Partially/totally nonambulatory	30	Partially/totally nonambulatory	24	All patients	100
13. Nutrition	Admission Albumin <= 3.0	7	Admission Albumin <= 3.0	3	Malnourished Admission Albumin <= 3.0	29	Malnourished Admission Albumin <= 3.0 Morbidly obese	9	Cachetic Admission Albumin <= 3.0	11

Table B.6

NUMBER OF BODY SYSTEM PROBLEMS NOTED AT ADMISSION ACROSS DISEASES
(in percent; pre- and post-PPS sample combined)

Number of Body System Problems	CHF (n=2824)		AMI (n=2853)		PNE (n=2749)		CVA (n=2824)		HIP (n=2762)	
	%	% Cum	%	% Cum	%	% Cum	%	% Cum	%	% Cum
1	15	15	28	28	9	9	7	7	19	19
2	29	44	37	65	16	25	27	36	27	45
3	28	72	21	87	22	47	30	66	26	71
4	17	89	10	96	20	67	21	87	19	90
5	8	97	3	99	15	83	9	96	7	97
6	2	99	1	100	11	94	4	99	3	100
7	1	100	0	100	5	98	1	100	0	100
8	0	100	0	100	2	100	0	100	0	100
9	0	100	0	100	0	100	0	100	0	100

Table B.7

AMI NORRIS CORONARY PROGNOSTIC INDEX
(pre- and post-PPS sample combined)

	Code	Score	% of Patients (n=2853)
Age			
>= 80	1	3.9	26.9
70-79	2	3.1	49.1
< 70	3	2.3	23.9
MI location/extent (1)			
MD: anterior & inferior	1	3.0	1.1
MD: anterior	2	2.8	27.3
MD: inferior	3	2.0	24.9
MD: transmural but location unspecified	4	2.0	9.3
MD: subendocardial	5	0.84	16.1
EKG: anterior	6	2.8	1.2
EKG: inferior	7	2.0	1.0
EKG: transmural but location unspecified	8	2.0	0.1
EKG: subendocardial	9	0.84	1.1
EKG: no evidence of MI	10	0	12.9
no EKG	M	0	5.2
Systolic blood pressure on admission			
< 55	1	10	0.5
55-64	2	7	0.7
65-74	3	6	0.7
75-84	4	5	2.1
85-94	5	4	2.9
95-104	6	3	4.9
105-114	7	2	7.5
115-124	8	1	10.5
>= 125	9	0	69.8
No measurement on admission	M	0	0.5
Cardiomegaly by CXR			
Yes	1	1.1	43.8
No	0	0	48.2
No CXR D1H or D2H	M	0	8.0
Pulmonary Congestion			
Severe CHF by CXR	1	3.3	8.1
Moderate CHF by CXR	2	2.0	9.3
Mild CHF by CXR	3	1.0	17.7
Lungs not clear.MD exam and unlikely or no CHF by CXR	4	1.0	24.0
History of Ischemia			
Prior angina or prior MI	1	0.4	46.7

AMI: 3/10/89, 11:49, JK

(1) Defined by an MD review. If the MD did not identify an MI (codes 1-5), the MI location as described on the EKGs report on days 1 or 2 was used.

Table B.8 shows the distribution of patients by the variables used in the Killip Scale for categorizing patients with acute myocardial infarction for the pre- and post-PPS sample combined (Killip and Kimball, 1967).

Table B.9 shows the distribution of patients by variables used in RAND's mental status measure for patients with cerebrovascular accident by frequency and mortality rates. The RAND clinical weights are based upon clinician judgment.

Table B.10 compares the distribution of patients by RAND's mental status measure (as defined in Table B.9) and the APACHE APS mental status measure for the pre- and post-PPS sample combined. This allows one to see the percentage distribution of patients by the more detailed categories of the RAND measure and the less detailed categories of RAND's interpretation of the APACHE measures.

Table B.11 shows the distribution and mortality rates for patients by variables used in the Goldman Cardiac Risk Index for the pre- and post-PPS hip fracture sample combined (Goldman et al., 1977).

Table B.12 shows the distribution of APACHE II APS variables for five diseases in the pre- and post-PPS sample. The codes refer to variable categories used in the PPS data set. The scores refer to the number of points assigned for patient values in each category. The scores presented were developed by Knaus et al. (1985).

Table B.13 shows the distribution of patients by RAND Acute Complexity (sickness-at-admission) variables for the pre- versus post-PPS sample. These disease-specific lists of variables are designed to measure acute morbid and comorbid conditions present at the time of hospital admission. Abbreviations used in Table B.13 are listed below:

AF	Atrial fibrillation
CPK	Creatine phosphokinase

Table B.14 shows the distribution of patients by RAND Chronic Complexity (sickness-at-admission) variables for the pre- versus post-PPS sample. The disease-specific lists of

Table B.8

AMI: KILLIP MI SEVERITY
(pre- and post-PPS sample combined)

	% of Patients (n=2853)
MD identifies shock D2H or SBP < 90 D1H or D2H	25.7
Severe CHF by CXR D1H or D2H	6.8
Moderate or mild CHF by CXR D1H or D2H	19.9
Unlikely or no CHF by CXR D1H or D2H	42.2

Table B.9

RAND's MENTAL STATUS MEASURE FOR PATIENTS WITH CEREBROVASCULAR ACCIDENT BY FREQUENCY AND MORTALITY RATES
(pre- and post-PPS sample combined)

Patient's Mental Status Described in the Medical Record	RAND Clinical Weight	Frequency of Patients		In-Hospital Mortality (% Dead)
		n	%	
No mental status problem problem identified by physician or nurse	0	937	33.2	4.3
Confusion noted by physician or nurse	1	448	15.9	8.0
Change in neurologic status or patient unable to follow commands noted by physician or nurse	2	702	24.9	16.4
Coma noted by physician or nurse	3	301	10.7	32.2
Coma noted by physician and nurse	4	224	7.9	60.7
Posturing or no response to pain noted by physician	5	212	7.5	67.9
Total		2824	100.0	20.1

Table B.10

Distribution of Patients with Cerebrovascular Accident by RAND's Mental Status Measure and by APACHE APS Measure (Pre- and Post-PPS Sample Combined)

Patient's mental status described in the medical record using RAND's mental status measure (2)	RAND Clinical Weight	Frequency (# of patients)	APACHE APS Designation (1)(2): No Mental Status Problem Identified (i.e., score = 0)	Confusion (i.e., score = 5)	Coma (i.e., score = 9)
			Distribution of Patients (%)		
No mental status problem problem identified by physician or nurse	0	937	100	0	0
Confusion (3) noted by physician or nurse	1	448	0	100	0
Change in neurologic status (4) or patient unable to follow commands noted by physician or nurse	2	702	3	97	0
Coma noted by physician or nurse	3	301	3	24	73
Coma noted by physician and nurse	4	224	0	0	100
Posturing or no response to pain noted by physician	5	212	2	5	93
Total		2824	34	43	23

(1) APACHE APS definition of mental status is based upon the Glascow Coma Scale.

(2) APACHE APS as coded by RAND data collector: Coma is assigned 9 points; confusion or neurologic change is assigned 5 points; the abscence of coma, confusion and/or neurologic change is assigned 0 points.

(3) Confusion is defined as the physician or nurse on day 1 of the hospitalization documenting in the medical record the patient was disoriented (×1, 2, or 3); oriented × 1 or 2; unable to identify time, place, self, friends, or family; unable to follow simple commands or answer simple questions.

(4) Change in neurologic status is defined as the physician or nurse on day 1 of the hospitalization documenting the patient as being any of the following: agitated, restless, somnolent, lethargic, poor arousable, semicomatose, stuporous, obtunded, drowsy; or as having seizure, syncope, or los of consciousness.

Table B.11

GOLDMAN CARDIAC RISK INDEX
(pre- and post-PPS sample combined; n = 2762)

	Distribution of Patients		
	n	%	% Mortality
Goldman score day 1, 2 (all patients, regardless of surgery)			
0-9	1735	62.8	3.0
10-16	802	29.0	6.4
>= 17	225	8.2	7.6
All	2762	100	4.4
Goldman score day 1, 2 (only patients with surgery)			
0-9	1634	63.1	2.8
10-16	747	28.9	4.8
>= 17	206	8.0	5.8
All	2587	100	3.6
Goldman score day 1, 2 (only patients with no surgery)			
0-9	101	57.7	6.9
10-16	55	31.4	27.3
>= 17	19	10.9	26.3
All	175	100	15.4
Goldman score immediately before surgery (only patients with surgery)			
0-9	1682	65.0	3.0
10-16	714	27.6	4.5
>= 17	191	7.4	6.3
All	2587	100	3.6

Table B.12

DISTRIBUTION OF APACHE II APS VARIABLES FOR FIVE DISEASES
(Pre-PPS versus Post-PPS)

Page 1 of 3

			CHF		AMI		PNE		CVA		HIP	
	Code	Score	PRE (n=1359)	POST (n=1465)	PRE (n=1416)	POST (n=1437)	PRE (n=1341)	POST (n=1408)	PRE (n=1382)	POST (n=1442)	PRE (n=1358)	POST (n=1404)
APACHE Temperature												
C < = 29.9	1	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C = 30-31.9	2	3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
C = 32-33.9	3	2	0.1	0.3	0.1	0.3	0.1	0.1	0.1	0.2	0.1	0.0
C = 34-35.9	4	1	16.3	20.9	18.0	22.0	4.9	6.3	11.4	15.5	8.4	11.8
C = 36-38.4	5	0	81.2	77.4	78.9	75.8	68.9	72.3	85.0	81.8	90.9	87.7
C = 38.5-38.9	6	1	0.8	0.9	0.4	0.5	12.9	10.2	1.5	1.2	0.3	0.1
C = 39-40.9	7	3	0.7	0.5	0.1	0.3	12.8	11.1	1.4	0.9	0.1	0.4
C > = 41	8	4	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0
Missing	M	-	0.9	0.1	2.4	1.1	0.1	0.0	0.4	0.3	0.2	0.1
APACHE Mean Blood Pressure (MPB)												
MBP < = 49	1	4	0.2	0.5	2.8	2.7	1.3	1.6	0.8	0.3	0.2	0.1
MBP = 50-69	2	2	1.9	1.8	2.7	3.4	6.5	7.0	1.5	1.3	1.2	0.9
MBP = 70-109	3	0	61.0	60.9	54.1	56.0	75.5	74.3	43.9	47.9	61.6	60.6
MBP = 110-129	4	2	24.9	24.8	28.5	26.9	13.6	13.2	32.8	33.5	28.8	30.3
MBP = 130-159	5	3	10.3	10.8	10.0	9.9	2.9	3.7	18.1	14.7	7.6	7.5
MBP >= 160	6	4	1.2	1.2	1.3	0.7	0.0	0.2	2.5	2.0	0.5	0.5
Missing	M	-	0.4	0.0	0.6	0.4	0.2	0.1	0.4	0.2	0.1	0.0
APACHE Heart Rate (HR)												
HR < = 39	1	4	0.2	0.1	0.5	1.0	0.1	0.0	0.2	0.0	0.1	0.1
HR = 40-54	2	3	1.8	1.5	4.4	3.9	0.4	0.4	2.2	1.8	0.4	0.4
HR = 55-69	3	2	11.8	9.2	17.7	17.7	6.1	6.0	18.4	17.1	11.3	13.0
HR = 70-109	4	0	63.9	67.0	61.5	57.9	68.9	68.2	69.8	72.1	83.1	81.5
HR = 110-139	5	2	17.6	17.5	12.1	14.7	20.6	21.3	7.7	7.5	4.9	4.8
HR = 140-179	6	3	4.2	4.4	2.9	4.1	3.7	3.8	1.2	1.3	0.2	0.2
HR > = 180	7	4	0.4	0.4	0.1	0.3	0.1	0.3	0.1	0.0	0.0	0.0
Missing	M	-	0.2	0.0	0.7	0.3	0.1	0.1	0.4	0.2	0.0	0.0
APACHE Respiratory Rate (RR)												
RR < = 5	1	4	0.1	0.0	0.4	0.4	0.1	0.0	0.1	0.4	0.0	0.0
RR = 6-9	2	2	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.3	0.0	0.0
RR = 10-11	3	1	0.0	0.1	0.3	0.5	0.1	0.1	0.4	0.3	0.0	0.1
RR = 12-24	4	0	55.6	51.8	75.9	74.0	55.1	52.0	83.6	83.6	92.3	92.2
RR = 25-34	5	1	29.7	31.9	15.8	16.3	26.0	29.9	10.9	12.1	6.3	6.7
RR = 35-49	6	3	13.1	15.2	6.2	7.7	17.2	16.8	4.0	2.8	1.0	0.8
RR > = 50	7	4	1.0	0.6	0.4	0.5	1.3	1.0	0.1	0.1	0.1	0.1
Missing	M	-	0.4	0.3	1.0	0.4	0.1	0.1	0.7	0.3	0.2	0.0
APACHE pH												
pH < 7.15	1	4	1.8	1.6	2.6	3.5	0.7	1.1	0.2	1.1	0.1	0.0
pH = 7.15-7.24	2	3	2.3	3.3	2.0	3.3	1.4	1.8	1.0	0.6	0.0	0.4
pH = 7.25-7.32	3	2	4.0	5.5	3.4	5.1	3.5	3.0	1.5	1.9	0.1	0.6
pH = 7.33-7.49	4	0	36.6	47.0	31.2	37.0	39.7	48.4	21.3	28.0	12.2	16.2
pH = 7.5-7.59	5	1	5.6	6.2	3.7	4.4	6.5	8.4	2.0	2.3	1.8	1.9
pH = 7.6-7.69	6	3	0.0	0.2	0.8	0.5	0.0	0.2	0.2	0.1	0.1	0.2
pH > = 7.7	7	4	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0
Missing	M	-	49.7	36.2	56.1	46.1	48.2	37.1	73.7	65.8	85.6	80.7

Table B.12

DISTRIBUTION OF APACHE II APS VARIABLES FOR FIVE DISEASES
(Pre-PPS versus Post-PPS)

			CHF		AMI		PNE		CVA		HIP	
	Code	Score	PRE (n=1359)	POST (n=1465)	PRE (n=1416)	POST (n=1437)	PRE (n=1341)	POST (n=1408)	PRE (n=1382)	POST (n=1442)	PRE (n=1358)	POST (n=1404)
							(% of patients)					
APACHE Oxygen												
p02 < 55	1	4	11.5	12.8	5.0	7.7	14.9	20.0	2.5	2.5	1.6	3.8
p02 = 55-60	2	3	6.1	7.4	3.5	3.0	8.7	12.5	1.6	2.8	1.8	2.7
p02 = 61-70	3	1	10.2	12.7	7.4	7.7	13.9	13.7	6.0	5.4	4.9	5.2
p02 > 70	4	0	21.7	29.2	24.9	30.5	13.3	15.3	14.9	21.4	6.0	7.1
AaD02 < 200	5	0	0.0	0.1	0.3	0.4	0.1	0.0	0.3	0.4	0.0	0.0
Aa002 = 200-349	6	2	0.2	0.3	0.6	1.3	0.1	0.7	0.5	0.3	0.0	0.3
AaD02 = 350-499	7	3	0.1	0.4	0.6	1.0	0.1	0.0	0.2	0.4	0.0	0.1
AaD02 > = 500	8	4	0.5	1.0	1.6	2.2	0.7	0.8	0.2	0.9	0.0	0.2
Missing	M	-	49.7	36.0	56.2	46.1	48.2	37.1	73.7	65.8	85.7	80.7
If FL02 > = 50, Aa002 = (FL02(713) - pC02 - p02) is used												
APACHE Sodium (Na)												
Na < = 110	1	4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0
Na = 111-119	2	3	0.7	0.8	0.2	0.1	0.8	0.6	0.2	0.2	0.2	0.2
Na = 120-129	3	2	3.7	5.5	4.0	3.8	6.0	6.7	3.0	2.5	4.3	4.6
Na = 130-149	4	0	87.6	89.6	87.2	89.9	76.0	82.0	83.1	89.5	82.9	86.5
Na = 150-154	5	1	0.4	0.7	0.2	0.9	1.7	1.9	0.9	0.8	0.3	0.6
Na = 155-159	6	2	0.1	0.0	0.1	0.1	0.8	0.9	0.4	0.3	0.0	0.0
Na = 160-179	7	3	0.3	0.0	0.1	0.1	0.6	1.1	0.8	0.3	0.1	0.1
Na > = 180	8	4	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Missing	M	-	7.1	3.4	8.1	4.9	13.8	6.7	11.6	6.3	12.2	8.0
APACHE Potassium (K)												
K < 2.5	1	4	0.7	0.5	0.2	0.1	0.5	0.1	0.7	0.3	0.5	0.1
K = 2.5-2.9	2	2	2.2	1.7	2.8	2.6	2.9	3.1	4.1	1.9	2.9	2.6
K = 3.0-3.4	3	1	8.8	9.8	12.1	11.3	9.2	11.5	13.3	14.0	10.5	11.2
K = 3.5-5.4	4	0	78.0	79.9	75.6	77.8	70.8	75.3	69.1	76.1	73.0	78.1
K = 5.5-5.9	5	1	2.1	3.5	1.1	2.1	2.0	2.6	0.7	1.1	1.3	0.8
K = 6.0-6.9	6	3	1.6	1.3	0.7	1.4	0.8	0.8	0.4	0.7	0.2	0.3
K > = 7.0	7	4	0.0	0.3	0.1	0.1	0.3	0.0	0.0	0.1	0.1	0.1
Missing	M	-	6.6	2.9	7.4	4.6	13.3	6.6	11.7	5.8	11.5	6.8
APACHE Creatinine (Cr)												
Cr < 0.6	1	2	0.1	0.3	0.4	0.1	0.7	1.2	0.3	0.7	1.0	1.6
Cr = 0.6-1.4	2	0	38.0	43.6	43.3	50.9	42.9	52.1	44.9	56.7	47.5	60.1
Cr = 1.5-1.9	3	2	16.3	19.4	14.3	16.0	12.2	14.0	10.6	15.0	6.0	7.8
Cr = 2.0-3.4	4	3	11.3	14.5	6.1	9.3	6.9	8.9	5.1	5.5	2.3	3.2
Cr > = 3.5	5	4	3.2	3.1	1.6	2.2	2.2	2.3	1.4	1.2	0.6	0.7
BUN = < 10	6	2	0.4	0.5	0.6	0.2	1.0	0.9	0.7	0.8	1.3	1.1
BUN = 10-20	7	0	7.4	5.7	13.1	7.8	10.4	6.1	13.0	7.8	14.9	8.5
BUN = 21-80	8	1	11.8	6.7	9.3	5.8	8.9	5.8	9.4	5.8	12.1	7.1
BUN = 81-100	9	2	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.1	0.0
BUN = 101-150	10	3	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0
BUN > 150	11	4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Missing	M	-	11.3	6.0	11.3	7.6	14.5	8.4	14.4	6.5	14.4	9.9
BUN is used if no Creatinine												

Table B.12

DISTRIBUTION OF APACHE II APS VARIABLES FOR FIVE DISEASES
(Pre-PPS versus Post-PPS)

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	Code	Score	CHF PRE (n=1359)	CHF POST (n=1465)	AMI PRE (n=1416)	AMI POST (n=1437)	PNE PRE (n=1341)	PNE POST (n=1408)	CVA PRE (n=1382)	CVA POST (n=1442)	HIP PRE (n=1358)	HIP POST (n=1404)
APACHE Hematocrit (HCT)												
HCT or (Hgbx3) < 20	1	4	0.8	0.7	0.4	0.1	0.3	0.3	0.1	0.1	0.3	0.1
HCT or (Hgbx3) = 20-29.9	2	2	4.6	8.5	2.2	3.5	5.2	7.0	2.0	2.8	8.2	8.8
HCT or (Hgbx3) = 30-45.9	3	0	75.0	76.2	75.3	78.6	83.6	81.5	76.6	78.5	85.1	85.0
HCT or (Hgbx3) = 46-49.9	4	1	8.2	6.3	13.4	11.0	6.5	6.7	11.4	10.4	2.3	2.2
HCT or (Hgbx3) = 50-59.9	5	2	2.5	2.5	3.4	3.1	2.8	2.4	3.7	3.2	0.6	0.4
HCT or (Hgbx3) > = 60	6	4	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.3	0.0	0.0
Missing	M	-	8.7	5.7	5.3	3.7	1.6	2.0	6.2	4.7	3.5	3.4
Hgb used if no HCT												
APACHE White Blood Cell Count (WBC)												
WBC < 1	1	4	0.1	0.0	0.0	0.0	0.1	0.4	0.0	0.1	0.0	0.0
WBC = 1-2.9	2	2	0.4	0.4	0.3	0.0	1.2	1.1	0.5	0.1	0.1	0.2
WBC = 3-14.9	3	0	82.8	84.2	84.5	81.1	66.7	59.6	85.0	85.6	83.4	82.5
WBC = 15-19.9	4	1	5.6	6.3	6.8	11.1	17.8	20.3	6.3	6.7	10.1	10.6
WBC = 20-39.9	5	2	2.4	2.8	2.8	3.8	12.4	15.6	2.1	2.5	2.6	3.0
WBC > = 40	6	4	0.1	0.2	0.1	0.1	0.4	1.1	0.1	0.3	0.0	0.1
Missing	M	-	8.6	6.1	5.6	3.8	1.4	1.9	6.0	4.8	3.9	3.6
APACHE Coma Scale												
Coma	1	9	1.3	1.1	3.9	4.0	6.0	5.8	23.6	21.8	--	--
Confusion (MD or RN) and Neuro change (MD or RN)	2	5	5.7	6.8	24.9	28.9	13.6	15.8	11.5	14.6	8.8	9.7
Neuro change (MD or RN) only	3	5	10.1	9.4	0.0	0.0	12.8	13.1	12.1	12.2	4.3	4.3
Confusion (MD or RN) only	4	5	8.8	8.7	0.0	0.0	11.1	12.8	18.1	17.2	23.0	21.2
No Neurologic deficit	0	0	74.2	74.0	71.2	67.1	56.5	52.4	34.7	34.1	63.8	64.7
APACHE Venous Bicarbonate (HCO3)												
HCO3 < 15	1	4	0.7	1.1	1.1	1.0	0.7	1.1	0.7	0.6	--	--
HCO3 = 15-17.9	2	3	2.0	1.8	2.2	2.9	1.4	1.5	1.1	1.0	--	--
HCO3 = 18-21.9	3	2	8.2	8.2	7.6	10.9	6.0	6.2	6.2	7.8	--	--
HCO3 = 22-31.9	4	0	56.2	61.0	65.8	66.8	58.1	62.4	64.0	68.2	--	--
HCO3 = 32-40.9	5	1	12.2	13.5	4.5	6.0	9.7	11.6	6.0	8.5	--	--
HCO3 = 41-51.9	6	3	0.5	1.0	0.2	0.1	0.5	0.9	0.1	0.2	--	--
HCO3 > = 52	7	4	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	--	--
Missing	M	-	20.0	13.4	18.6	12.4	23.4	16.5	21.9	13.8	--	--

Table B.13

Distribution of RAND Acute Complexity Variables
(Pre-PPS versus Post-PPS)

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	CHF		AMI		PNE		CVA		HIP	
	% of Patients		% of Patients		% of Patients		% of Patients		% of Patients	
	Pre n=1359	Post n=1465	Pre n=1416	Post n=1437	Pre n=1341	Post n=1408	Pre n=1382	Post n=1442	Pre n=1358	Post n=1404
Arrest in ER	0.2	1.1	----	----	----	----	----	----	----	----
Arrest or intubation in ER	----	----	----	----	2.1	2.5	2.7	4.0	0.2	0.1
Arrest within 24 hrs prior to admission	----	----	2.8	3.1	----	----	----	----	----	----
Intubation D1H	2.0	2.9	6.4	9.1	3.4	4.5	3.8	4.6	----	----
CXR.CHF:										
Severe	14.9	17.1	7.1	8.4	3.1	3.2	2.1	1.3	0.3	0.8
Moderate	30.9	35.4	7.8	9.3	3.5	4.5	2.9	2.8	0.4	1.0
Mild	30.3	27.4	17.4	16.1	20.2	18.9	12.3	10.8	6.5	8.3
Unlikely or no CHF	18.0	16.1	52.0	53.2	70.2	71.2	62.8	64.1	85.1	83.0
no CXR	3.9	6.0	15.7	13.0	3.0	2.1	19.9	20.9	7.7	6.8
CXR.PNE:										
Unilat. PNE	4.3	4.4	----	----	44.5	40.8	3.0	2.8	1.5	1.4
Unilat.Infiltrate	4.1	4.9	----	----	17.6	18.6	2.5	2.4	1.8	1.9
Bilat.PNE or infiltrate/No CHF	1.0	1.8	----	----	17.1	18.2	0.9	1.0	0.9	0.6
Bilat.PNE or infiltrate/CHF	6.1	7.4	----	----	6.4	6.7	0.7	0.8	0.2	0.5
Unlikely PNE or infiltrate	8.4	9.3	----	----	6.6	7.5	6.7	8.0	5.2	7.3
No evidence	70.2	68.2	----	----	4.8	6.5	66.2	64.1	82.5	81.5
No CXR	6.0	3.9	----	----	3.0	2.1	19.9	20.9	7.7	6.8
Cardiac Enzymes (CPK) at admission:										
CPK value > CPK.HNV x 3	1.8	1.6	49.2	52.7	1.9	2.3	2.7	3.8	----	----
CPK value > CPK.HNV x 1.5	2.3	3.3	14.4	17.3	1.6	1.8	2.7	2.5	----	----
CPK value > CPK.HNV x 1.0	2.6	3.8	6.4	6.3	2.1	2.0	2.7	3.3	----	----
CPK value <= CPK.HNV	40.6	49.0	22.9	20.2	19.1	23.2	23.1	26.8	----	----
Atrial Arrhythmias.EKG										
AF etc.	----	----	----	----	----	----	----	----	6.6	7.9
PACs	----	----	----	----	----	----	----	----	7.8	6.5
no atrial arrhythmias	----	----	----	----	----	----	----	----	76.1	78.3
no EKG	----	----	----	----	----	----	----	----	9.6	7.3
Ventricular arrhythmias.EKG										
V-tach	----	----	----	----	----	----	----	----	0.0	0.0
PVC's	----	----	----	----	----	----	----	----	8.7	8.1
no ventricular arrhythmias	----	----	----	----	----	----	----	----	81.7	84.5
no EKG	----	----	----	----	----	----	----	----	9.6	7.3
Heart block.EKG:										
3rd degree	----	----	----	----	----	----	----	----	0.4	0.0
2nd degree	----	----	----	----	----	----	----	----	0.1	0.1
1st degree	----	----	----	----	----	----	----	----	7.9	7.7
sinus bradycardia	----	----	----	----	----	----	----	----	1.5	1.7
no rhythm disturbance	----	----	----	----	----	----	----	----	80.6	83.1
no EKG	----	----	----	----	----	----	----	----	9.6	7.3

Table B.13

Distribution of RAND Acute Complexity Variables
(Pre-PPS versus Post-PPS)

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	CHF		AMI		PNE		CVA		HIP	
	% of Patients		% of Patients		% of Patients		% of Patients		% of Patients	
	Pre n=1359	Post n=1465	Pre n=1416	Post n=1437	Pre n=1341	Post n=1408	Pre n=1382	Post n=1442	Pre n=1358	Post n=1404
Angina within 1 week prior	4.7	7.0	----	----	----	----	0.2	1.4	----	----
CHF within 1 week prior	----	----	----	----	----	----	1.4	1.7	----	----
Digitalis level at admission										
Highest dig level > 2.2	3.5	4.6	----	----	----	----	----	----	0.3	0.3
Highest dig level <= 2.2	34.9	39.8	----	----	----	----	----	----	4.3	6.8
No dig level at admission	61.6	55.6	----	----	----	----	----	----	95.4	92.9
SGOT at admission										
SGOT >= 80	6.1	6.3	23.8	24.6	5.6	5.2	2.9	2.3	2.0	2.3
SGOT = 40-79	15.2	13.5	21.0	19.8	13.3	11.3	9.4	9.9	8.6	7.7
SGOT < 40	56.4	54.7	43.4	41.2	54.0	49.2	59.8	60.2	59.3	50.4
no SGOT at admission	22.2	25.5	11.8	14.4	27.1	34.4	27.9	27.6	30.1	39.7
Bilirubin at admission										
Bilirubin >= 4	0.9	0.7	1.0	0.1	0.8	0.4	0.1	0.1	0.1	0.5
Bilirubin = 2-3.9	4.0	3.4	1.1	0.8	2.8	1.1	1.2	0.8	1.1	1.1
Bilirubin = 1.2-1.9	9.8	9.8	5.0	4.7	6.7	6.5	6.2	5.8	6.3	5.1
Bilirubin < 1.2	57.9	54.6	65.1	66.2	61.1	56.0	62.2	64.2	62.2	55.2
No Bilirubin at admission	27.4	31.5	27.8	28.2	28.5	36.1	30.3	29.1	30.3	38.2
Positive blood culture with fever on D1H or D2H	0.4	0.2	----	----	----	----	----	----	----	----
Positive blood culture or bacteremia/sepsis D1H or D2H	----	----	----	----	7.4	10.1	----	----	----	----
Positive Urine culture D1H or D2H	----	----	----	----	9.6	12.2	----	----	----	----
Pre op confusion (regardless of dementia) D1H	----	----	----	----	----	----	----	----	36.2	35.3
Influenza within 2 weeks prior	----	----	----	----	3.8	3.8	----	----	----	----
Respiratory distress at admission	----	----	----	----	11.5	15.2	----	----	----	----
Wheezing at admission	----	----	----	----	19.9	25.6	----	----	----	----
Empyema at admission	----	----	----	----	0.0	0.6	----	----	----	----
Lung abscess at admission	----	----	----	----	0.1	0.6	----	----	----	----
Meningitis at admission	----	----	----	----	0.1	0.1	----	----	----	----
Pericarditis at admission	----	----	----	----	0.0	0.1	----	----	----	----
Endocarditis at admission	----	----	----	----	0.1	0.1	----	----	----	----
Prior antibiotics	----	----	----	----	20.4	26.1	----	----	----	----

Table B.13

Distribution of RAND Acute Complexity Variables
(Pre-PPS versus Post-PPS)

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	CHF		AMI		PNE		CVA		HIP	
	% of Patients		% of Patients		% of Patients		% of Patients		% of Patients	
	Pre n=1359	Post n=1465	Pre n=1416	Post n=1437	Pre n=1341	Post n=1408	Pre n=1382	Post n=1442	Pre n=1358	Post n=1404
Fracture location										
Intertrochanteric	----	----	----	----	----	----	----	----	48.9	50.5
Femoral neck	----	----	----	----	----	----	----	----	47.3	46.2
Subtrochanteric	----	----	----	----	----	----	----	----	1.4	1.6
Other	----	----	----	----	----	----	----	----	2.4	1.6
No data	----	----	----	----	----	----	----	----	0.1	0.1
Fracture Stability										
Garden Stage: 1	----	----	----	----	----	----	----	----	0.3	0.7
2	----	----	----	----	----	----	----	----	0.3	0.9
3/4	----	----	----	----	----	----	----	----	1.5	4.8
No data/not applicable	----	----	----	----	----	----	----	----	97.9	93.7
Displaced fracture	----	----	----	----	----	----	----	----	50.0	54.0
Comminuted fracture	----	----	----	----	----	----	----	----	30.1	33.0
Impacted fracture	----	----	----	----	----	----	----	----	18.9	19.9
Stable fracture	----	----	----	----	----	----	----	----	1.1	1.3
Valgus fracture	----	----	----	----	----	----	----	----	3.9	3.8
Varus fracture	----	----	----	----	----	----	----	----	31.3	30.1
Speech deficit										
Aphasia	----	----	----	----	----	----	21.9	23.1	----	----
Not able to speak	----	----	----	----	----	----	7.5	6.2	----	----
Speaks with difficult	----	----	----	----	----	----	30.5	32.7	----	----
Deficit not described	----	----	----	----	----	----	0.3	0.3	----	----
No deficit	----	----	----	----	----	----	39.8	37.7	----	----
Motor deficit	----	----	----	----	----	----	85.5	88.2	----	----
Coma scale										
Decorticate, decerebrate.MD	----	----	----	----	----	----	2.4	3.7	----	----
No response to pain.MD	----	----	----	----	----	----	4.6	4.3	----	----
Coma.MD and Coma.RN	----	----	----	----	----	----	8.9	7.0	----	----
Coma.MD or Coma.RN	----	----	----	----	----	----	11.0	10.3	----	----
Neurochange.MD or Neuro Change.RN. or unable to follow commands.MD	----	----	----	----	----	----	23.7	26.0	----	----
Confused.MD or confused.RN	----	----	----	----	----	----	16.3	15.5	----	----
No deficit	----	----	----	----	----	----	33.1	33.2	----	----
Face deficit	----	----	----	----	----	----	47.9	50.6	----	----
Visual deficit	----	----	----	----	----	----	38.2	41.0	----	----
Sensory deficit of limbs	----	----	----	----	----	----	19.9	22.5	----	----
Seizure	----	----	----	----	----	----	5.1	6.1	----	----
Type of CVA										
Hemorrhage	----	----	----	----	----	----	9.8	11.4	----	----
Lacunar	----	----	----	----	----	----	3.2	8.0	----	----
Increased intracranial pressure	----	----	----	----	----	----	5.5	7.6	----	----

Table B.14

Distribution of RAND Chronic Complexity Variables (Pre-PPS versus Post-PPS)

	CHF		AMI		PNE	
	% of Patients		% of Patients		% of Patients	
	PRE (n=1359)	POST (n=1465)	PRE (n=1416)	POST (n=1437)	PRE (n=1341)	POST (n=1408)
Prior valvular disease	10.7	12.6	3.2	3.5	----	----
Critical Aortic Stenosis	----	----	----	----	----	----
Prior Angina	14.0	19.2	28.6	30.3	----	----
Prior Chest pain unknown origin	8.8	6.8	17.2	14.7	----	----
Prior MI: time unspecified	----	----	29.1	32.5	----	----
Prior MI: <=3 months	----	----	----	----	----	----
4-6 months	----	----	----	----	----	----
>=7 months	----	----	----	----	----	----
Prior MI: <=3 months	2.8	3.9	----	----	----	----
>=4 months	19.8	23.5	----	----	----	----
Prior pacemaker	9.5	11.1	2.4	2.7	----	----
Prior CHF	----	----	----	----	----	----
RAND prior CHF (1)	75.6	79.1	27.3	31.9	20.3	21.0
Prior hypertension	35.2	38.2	42.9	45.6	----	----
Prior Angioplasty	----	----	0.1	0.6	----	----
Prior CABS	----	----	2.0	5.4	----	----
Prior Angioplasty or CABS	2.4	4.6	----	----	----	----
Prior valvular disease/ angina/Mi/pacemaker/PCTA/ CABS	----	----	----	----	21.6	20.1
Prior Atrial Fibrillation	----	----	----	----	----	----
Prior Arrhythmia, excluding Atrial Fib	----	----	----	----	----	----
Prior Arrhythmia, including Atrial Fib	----	----	----	----	12.5	14.1

(1) RAND Prior CHF includes mention of CHF or use of digitalis prior to admission.

Table B.14

Distribution of RAND Chronic Complexity Variables
(Pre-PPS versus Post-PPS)

	CVA		HIP	
	% of Patients		% of Patients	
	PRE (n=1382)	POST (n=1442)	PRE (n=1358)	POST (n=1404)
Prior valvular disease	4.0	4.3	3.2	2.6
Critical Aortic Stenosis	----	----	0.4	0.3
Prior Angina	7.6	9.1	6.2	8.0
Prior Chest pain unknown origin	3.3	2.6	----	----
Prior MI: time unspecified	----	----	----	----
Prior MI: <=3 months	----	----	0.5	0.2
4-6 months	----	----	0.0	0.1
>=7 months	----	----	15.3	19.4
Prior MI: <=3 months	0.6	0.8	----	----
>=4 months	11.9	12.6	----	----
Prior pacemaker	3.2	4.4	2.0	2.0
Prior CHF	16.9	16.3	----	----
RAND prior CHF (1)	----	----	20.5	21.6
Prior hypertension	51.3	53.1	----	----
Prior Angioplasty	----	----	----	----
Prior CABS	----	----	----	----
Prior Angioplasty or CABS	0.9	1.9	----	----
Prior valvular disease/ angina/Mi/pacemaker/PCTA/ CABS	----	----	----	----
Prior Atrial Fibrillation	11.0	14.1	----	----
Prior Arrhythmia, excluding Atrial Fib	7.2	9.7	----	----
Prior Arrhythmia, including Atrial Fib	----	----	9.4	10.4

1) RAND Prior CHF includes mention of CHF or use of digitalis prior to admission.

Table B.14

Distribution of RAND Chronic Complexity Variables
(Pre-PPS versus Post-PPS)

	CHF		AMI		PNE	
	% of Patients		% of Patients		% of Patients	
	PRE (n=1359)	POST (n=1465)	PRE (n=1416)	POST (n=1437)	PRE (n=1341)	POST (n=1408)
Non-compliance	12.9	13.3	----	----	----	----
Prior Beta-Blocker	8.4	8.1	----	----	----	----
Prior Left Ventricular Depressant	2.6	5.2	----	----	----	----
RAND Prior Pharmacologic CHF	22.7	24.7	----	----	----	----
Prior Antiarrhythmics	12.1	19.7	----	----	----	----
Prior Cancer						
Poor prognosis cancer	NA	NA	0.6	0.7	1.0	1.3
Cancer, chemo or radiation Rx	NA	NA	1.0	1.0	1.9	2.0
Cancer, hormone Rx	0.1	0.3	0.2	0.1	0.4	0.4
Cancer, no evidence of activity	7.4	8.5	4.5	7.4	6.4	8.1
Immunocompromised	----	----	----	----	2.2	2.6
Prior Cirrhosis	1.5	1.6	0.3	0.4	1.1	1.0
Prior Diabetes	----	----	20.7	26.4	12.8	14.0
RAND Prior Diabetes (2)	23.3	26.8	----	----	----	----
Prior CVA	10.0	10.4	8.9	9.6	12.3	13.8
RAND prior chronic renal failure	2.3	3.1	0.0	0.4	0.1	0.1
Prior COPD	20.9	24.4	11.4	13.9	26.6	35.7
Prior Home O2	2.3	2.5	0.3	0.6	3.8	7.5
Pneumonectomy	----	----	----	----	1.1	0.6
Prior aspiration/ dysphagia/etc	----	----	----	----	3.4	5.5
Prior thoracic/abdominal surgery (<=1 month)	----	----	----	----	0.4	0.9
Prior neuromuscular disease of the thorax	----	----	----	----	0.4	0.3
Multiple myeloma	----	----	----	----	0.4	0.9

(2) RAND Prior Diabetes includes mention of diabetes OR insulin prior to admission.

Table B.14

Distribution of RAND Chronic Complexity Variables (Pre-PPS versus Post-PPS)

	CVA		HIP	
	% of Patients		% of Patients	
	PRE (n=1382)	POST (n=1440)	PRE (n=1358)	POST (n=1404)
Non-compliance	----	----	----	----
Prior Beta-Blocker	----	----	----	----
Prior Left Ventricular Depressant	----	----	----	----
RAND Prior Pharmacologic CHF	----	----	----	----
Prior Antiarrhythmics	----	----	----	----
Prior Cancer				
Poor prognosis cancer	0.9	0.8	0.7	1.3
Cancer, chemo or radiation Rx	1.2	1.3	1.5	2.0
Cancer, hormone Rx	0.2	0.3	0.0	0.0
Cancer, no evidence of activity	5.2	6.7	7.0	9.4
Immunocompromised	0.1	0.5	----	----
Prior Cirrhosis	0.7	0.4	1.2	1.1
Prior Diabetes	22.5	25.0	----	----
RAND Prior Diabetes (2)	----	----	11.8	11.1
Prior CVA	33.0	36.4	9.5	11.4
RAND prior chronic renal failure	0.2	0.9	0.1	0.5
Prior COPD	11.1	12.5	9.5	15.4
Prior Home O2	----	----	0.2	0.9
Pneumonectomy	----	----	0.3	0.6
Prior aspiration/ dysphagia/etc	----	----	----	----
Prior thoracic/abdominal surgery (<=1 month)	----	----	----	----
Prior neuromuscular disease of the thorax	----	----	----	----
Multiple myeloma	----	----	----	----

(2) RAND Prior Diabetes includes mention of diabetes OR insulin prior to admission.

Table B.14

Distribution of RAND Chronic Complexity Variables
(Pre-PPS versus Post-PPS)

	CHF		AMI		PNE	
	% of Patients		% of Patients		% of Patients	
	PRE (n=1359)	POST (n=1465)	PRE (n=1416)	POST (n=1437)	PRE (n=1341)	POST (n=1408)
Splenectomy	----	----	----	----	0.2	0.4
Respiratory Failure	----	----	----	----	1.1	3.2
Interstitial lung disease	----	----	----	----	2.6	3.4
Tracheostomy	----	----	----	----	0.4	0.7
Prior Aminophylline	----	----	----	----	11.0	17.7
New Lung cancer diagnosis	----	----	----	----	0.7	1.1
Prior Hospitalization						
<=1 month	----	----	----	----	13.8	17.7
<=6 months	34.4	34.9	----	----	----	----
for pulmonary disease	----	----	----	----	20.6	24.0
Prior Arterial Disease	2.9	2.9	2.2	2.8	----	----
Prior psychosis or depression	3.8	5.2	2.2	3.3	----	----
Difficulty with limbs	9.1	10.0	6.1	7.5	----	----
Prior deep vein thrombosis	----	----	----	----	----	----
Prior deep vein thrombosis or pulmonary embolism	----	----	----	----	----	----
Prior dementia						
Severe	1.3	1.6	0.3	0.7	4.2	5.4
Less severe	9.6	8.5	3.8	4.5	15.2	17.0
Current Smoker	10.0	9.4	12.8	14.5	12.3	12.9
Current Alcoholism	----	----	----	----	2.8	2.8
Prior Steroids	2.0	3.0	----	----	5.0	7.9
Albumin level or malnourished (3)						
Albumin < 2.5	1.0(1.0)	1.2(1.2)	0.4(0.4)	0.7(0.7)	2.5(2.5)	4.5(4.5)
Albumin = 2.5-3.0	6.3(6.3)	6.3(6.3)	1.5(1.5)	3.5(3.5)	13.6(13.6)	17.0(17.0)
Malnourished (albumin missing or > 3.0)	---- ---	---- ---	---- ---	---- ---	8.9(8.9)	11.2(11.2)
Albumin > 3.0	62.6(92.7)	58.8(92.5)	67.9(98.2)	65.9(95.8)	47.8(74.9)	36.2(67.4)
No data	30.1	33.7	30.3	29.9	27.1	31.2

(3) Numbers in parentheses based on the assumption that patients with no data are normal.

Table B.14

Distribution of RAND Chronic Complexity Variables (Pre-PPS versus Post-PPS)

	CVA		HIP	
	% of Patients		% of Patients	
	PRE (n=1382)	POST (n=1442)	PRE (n=1358)	POST (n=1404)
Splenectomy	----	----	----	----
Respiratory Failure	----	----	----	----
Interstitial lung disease	----	----	----	----
Tracheostomy	----	----	----	----
Prior Aminophylline	----	----	----	----
New Lung cancer diagnosis	----	----	----	----
Prior Hospitalization				
<=1 month	18.7	18.9	----	----
<=6 months	----	----	13.4	14.0
for pulmonary disease	----	----	----	----
Prior Arterial Disease	3.3	3.1	----	----
Prior psychosis or depression	3.8	5.1	4.8	5.5
Difficulty with limbs	----	----	----	----
Prior deep vein thrombosis	0.7	1.2	----	----
Prior deep vein thrombosis or pulmonary embolism	----	----	0.6	1.5
Prior dementia				
Severe	3.0	2.4	5.2	5.8
Less severe	12.2	11.9	19.5	20.2
Current Smoker	8.2	9.4	----	----
Current Alcoholism	2.3	2.8	----	----
Prior Steroids	1.9	2.1	2.9	4.1
Albumin level or malnourished (3)				
Albumin < 2.5	0.7(0.7)	0.6(0.6)	0.5(0.5)	0.6(0.6)
Albumin = 2.5-3.0	4.1(4.1)	3.9(3.9)	5.7(5.7)	4.9(4.9)
Malnourished (albumin missing or > 3.0)	----	----	5.4(5.4)	4.3(4.3)
Albumin > 3.0	62.2(95.2)	64.3(95.6)	57.7(88.3)	52.2(90.2)
No data	33.0	31.3	30.6	38.0

(3) Numbers in parentheses based on the assumption that patients with no data are normal.

Table B.14

Distribution of RAND Chronic Complexity Variables (Pre-PPS versus Post-PPS)

	CHF		AMI		PNE	
	% of Patients		% of Patients		% of Patients	
	PRE (n=1359)	POST (n=1465)	PRE (n=1416)	POST (n=1437)	PRE (n=1341)	POST (n=1408)
Malnourished	----	----	----	----	----	----
Nasogastric (NG) tube on day 1	----	----	----	----	----	----
NG tube prior to admission	----	----	----	----	2.1	4.5
Morbid Obesity	----	----	----	----	0.3	0.2
ESR						
ESR > 60	----	----	----	----	----	----
ESR <=60	----	----	----	----	----	----
No ESR test	----	----	----	----	----	----
Prior Anticoagulants	----	----	----	----	----	----
Prior Temporal Arteritis	----	----	----	----	----	----
Prior Lupus	----	----	----	----	----	----
Prior Carotid endarterectomy	----	----	----	----	----	----
Parkinson's Disease	----	----	----	----	----	----
Paget's Disease	----	----	----	----	----	----
Osteoarthritis	----	----	----	----	----	----
Rheumatoid Arthritis	----	----	----	----	----	----
New Dx-hip cancer (made during hospitalization)	----	----	----	----	----	----
Osteoporosis	----	----	----	----	----	----
Stress Fracture	----	----	----	----	----	----
Osteoporosis or stress fracture	----	----	----	----	----	----
Prior fracture--opposite hip	----	----	----	----	----	----
Urinary continence (3)						
Incontinent	9.9(9.9)	12.4(12.4)	----	----	19.3(19.3)	26.1(26.1)
Continent	55.2(90.1)	59.6(87.6)	----	----	46.6(80.7)	49.4(73.9)
No data	34.9	28.0	----	----	34.1	24.5

(3) Numbers in parentheses based on the assumption that patients with no data are normal.

Table B.14

Distribution of RAND Chronic Complexity Variables
(Pre-PPS versus Post-PPS)

	CVA		HIP	
	% of Patients		% of Patients	
	PRE (n=1382)	POST (n=1442)	PRE (n=1358)	POST (n=1404)
Malnourished	4.4	5.1	----	----
Nasogastric (NG) tube on day 1	5.1	6.7	----	----
NG tube prior to admission	----	----	----	----
Morbid Obesity	0.7	0.7	----	----
ESR				
ESR > 60	1.9	2.1	----	----
ESR <=60	13.4	16.0	----	----
No ESR test	84.7	82.0	----	----
Prior Anticoagulants	2.2	4.2	----	----
Prior Temporal Arteritis	0.1	0.1	----	----
Prior Lupus	0.6	1.1	----	----
Prior Carotid endarterectomy	1.5	3.1	----	----
Parkinson's Disease	----	----	2.9	4.4
Paget's Disease	----	----	0.7	0.5
Osteoarthritis	----	----	6.2	8.0
Rheumatoid Arthritis	----	----	0.1	0.0
New Dx-hip cancer (made during hospitalization)	----	----	0.4	0.4
Osteoporosis	----	----	21.0	24.9
Stress Fracture	----	----	0.1	0.1
Osteoporosis or stress fracture	----	----	21.0	25.0
Prior fracture--opposite hip	----	----	10.4	11.6
Urinary continence (3)				
Incontinent	15.6(15.6)	16.4(16.4)	15.3(15.3)	16.7(16.7)
Continent	44.7(84.4)	51.6(83.6)	47.1(84.7)	51.9(83.3)
No data	39.7	32.0	37.6	31.4

(3) Numbers in parentheses based on the assumption that patients with no data are normal.

Table B.14

Distribution of RAND Chronic Complexity Variables
(Pre-PPS versus Post-PPS)

	CHF		AMI		PNE	
	% of Patients		% of Patients		% of Patients	
	PRE (n=1359)	POST (n=1465)	PRE (n=1416)	POST (n=1437)	PRE (n=1341)	POST (n=1408)
Ambulatory status (3)						
Unable to walk	4.2(4.2)	4.8(4.8)	----	----	13.1(13.1)	16.1(16.1)
Walks with assistance	15.1(15.1)	18.7(18.7)	----	----	12.5(12.5)	17.3(17.3)
Probably able to walk	50.7(80.7)	55.5(76.5)	----	----	43.3(74.3)	44.2(66.6)
No data	30.0	21.0	----	----	31.0	22.4
Preadmission residence						
Home alone	17.5	19.8	14.3	17.4	9.8	11.9
Home with others	49.7	52.8	54.1	53.8	47.9	45.6
Home unspecified	16.3	11.5	18.4	15.5	13.3	11.3
Nursing home	7.4	8.3	3.6	5.1	21.6	25.3
Retirement home	1.3	2.4	1.1	1.5	2.4	2.8
Mental hospital	0.1	0.2	0.0	0.1	0.3	0.4
Chronic disease	0.0	0.0	0.0	0.0	0.0	0.0
Rehab hospital	0.1	0.1	0.0	0.1	0.1	0.4
Other	----	----	0.1	0.3	----	----
No data	7.6	4.8	8.4	6.3	4.5	2.4

(3) Numbers in parentheses based on the assumption that patients with no data are normal.

Data Sources:
CHF Complexity Scores-Dataset D4,19:01, August 9, 1988, NV
AMI Complexity Scores-Dataset , 0:13, February 15, 1989, JK
PNE Complexity Scores-Dataset G4,18:13, December 22, 1988, NV
CVA Complexity Scores-Dataset C4,18:00, January 17, 1989, NV
HIP Complexity Scores-Dataset E4,18:33, January 4, 1989, NV

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Table B.14

Distribution of RAND Chronic Complexity Variables
(Pre-PPS versus Post-PPS)

	CVA		HIP	
	% of Patients		% of Patients	
	PRE (n=1382)	POST (n=1442)	PRE (n=1358)	POST (n=1404)
Ambulatory status (3)				
Unable to walk	6.8(6.8)	7.5(7.5)	4.2(4.2)	4.0(4.0)
Walks with assistance	14.6(14.6)	18.3(18.3)	19.5(19.5)	24.3(24.3)
Probably able to walk	51.6(98.6)	54.4(74.2)	61.3(76.2)	63.2(71.7)
No data	27.0	19.8	14.9	8.5
Preadmission residence				
Home alone	16.6	17.8	21.9	23.4
Home with others	55.0	56.0	33.8	40.0
Home unspecified	11.4	8.9	13.1	10.0
Nursing home	11.9	11.0	23.7	19.2
Retirement home	2.2	3.3	4.3	4.9
Mental hospital	0.0	0.1	0.4	0.4
Chronic disease	0.0	0.0	0.0	0.0
Rehab hospital	0.1	0.1	0.0	0.0
Other	0.0	0.1	----	----
No data	2.8	2.8	2.7	2.2

(3) Numbers in parentheses based on the assumption that patients with no data are normal.

Data Sources: CHF D4,19:01, August 9, 1988, NV
AMI , 0:13, February 15, 1989, JK
PNE G4,18:13, December 22, 1988, NV
CVA C4,18:00, January 17, 1989, NV
HIP E4,18:33, January 4, 1989, NV

variables are designed to measure chronic morbid and comorbid conditions present at the time of hospital admission. Abbreviations used in Table B.14 are listed below:

Atrial Fib	Atrial fibrillation
ESR	Erythrocyte sedimentation rate

Table B.15 shows the distribution of patients by Body System variables for the pre- versus post-PPS sample. The disease-specific definitions of each variable are listed in the table.

SGOT	Serum Glutamic Oxalacetic Transaminase (ALT)
WBC	White blood cell

Table B.16 shows the distribution of patients by the number of body systems with sickness at admission for the pre- versus post-PPS sample. Body system sickness at admission is defined in Table B.5. Both percentages and cumulative (cum) percentages are listed.

Table B.17 shows the distribution of patients by the variables used in the Norris Coronary Prognostic Index (Norris et al., 1969). The codes refer to variable categories used in the PPS data set. The scores refer to the number of points assigned for patient values in each category. The scores presented were developed by Norris. Electrocardiograms from day 1 of the hospitalization were used to assign location and extent of the infarct. If no day 1 electrocardiogram was available, the day 2 electrocardiograms were used.

Table B.18 shows the distribution of patients by the variables used in the Killip Scale for Categorizing Patients with Acute Myocardial Infarction for the pre- versus post-PPS sample (Killip and Kimball, 1967).

Table B.19 shows the distribution and mortality rates for patients by variables used in the Goldman Cardiac Risk Index for the pre- versus post-PPS hip fracture sample (Goldman et al., 1977).

Table B.15

RAND BODY SYSTEM COUNT VARIABLES

Pre- and Post-PPS Sample Combined

	CHF Variable Definition	Pre n=1358 Frequency %	Post n=1465 Frequency %	AMI Variable Definition	Pre n=1416 Frequency %	Post n=1437 Frequency %	PNE Variable Definition	Pre n=1341 Frequency %	Post n=1408 Frequency %	CVA Variable Definition	Pre n=1382 Frequency %	Post n=1442 Frequency %	HIP Variable Definition	Pre n=1358 Frequency %	Post n=1404 Frequency %
1. Cardiac	All patients	100	100	All patients	100	100	Prior valvular disease/ angina/MI/pacemaker/ PTCA/CABS Prior CHF Prior Arrhythmias Pericarditis Endocarditis Prior Digitalis	44	45	Prior valvular disease Prior angina Prior MI Prior Pacemaker Prior CHF Prior PTCA/CABS Prior Hypertension Prior Atrial fibrillation Prior Other arrhythmias	71	73	Prior critical aortic stenosis (AS) Prior valvular disease angina/PTCA/CABS/aneurysm/ lower extremity bypass or amputation Prior MI Prior Arrhythmias Prior Pacemaker Prior CHF Prior Digitalis	33	36
2. Pulmonary	Prior COPD Prior Home O2 Current Smoker	26	29	Prior COPD Prior Home O2 Current Smoker	21	25	All Patients	100	100	Prior COPD Current smoker	17	19	Prior COPD Prior Home O2 Prior Pneumonectomy	10	16
3. Hepatobiliary	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	24	23	Prior cirrhosis Admission Bilirubin >= 2	2	1	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	22	18	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	13	13	Prior cirrhosis Admission SGOT >= 40 Admission Bilirubin >= 2	12	12
4. Endocrine	Prior Diabetes Prior Insulin	23	27	Prior Diabetes	21	26	Prior Diabetes	13	14	Prior Diabetes	23	25	Prior Diabetes Prior Insulin	12	11
5. Arterial	Prior lower extremity bypass or amputation	3	3	Prior lower extremity bypass or amputation	2	3	No Data	--	--	Prior lower extremity bypass or amputation Prior carotid endarterectomy (CE) Prior Temporal arteritis	5	6	Prior Deep Vein Thrombosis (DVT) or pulmonary embolus (PE)	1	2
6. Renal	Prior chronic renal failure Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	10	12	Prior chronic dialysis/ kidney transplant Admission Creatinine >= 2.0 Admission BUN >= 101	8	12	Prior chronic dialysis/kidney transplant Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	26	34	Prior chronic/renal failure Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	21	22	Prior chronic dialysis/kidney transplant Prior incontinence Admission Creatinine >= 2.0 Admission BUN >= 101	18	20
7. Neurologic	Prior Dementia Prior CVA Coma at admission Confusion at admission Neurologic change at admission	35	35	Prior Dementia Prior CVA Coma at admission Confusion at admission Neurologic change at admission	34	40	Prior Dementia Prior CVA Coma at admission Confusion at admission Neurologic change at admission Prior neuromuscular disease of thorax Meningitis	50	53	All patients	100	100	Prior Dementia Prior CVA Parkinson's disease Confusion at admission Neurologic change at admission	46	48
8. Psychiatric	Prior Depression/Psychosis	4	5	Prior Depression/Psychosis	2	3	No Data	--	--	Prior Depression/Psychosis Current alcoholism	6	8	Prior Depression/Psychosis	5	6
9. Oncologic	Prior Cancer (1)	8	9	Prior Cancer	6	9	Prior Cancer Prior Multiple Myeloma	10	12	Prior Cancer	7	9	Prior Cancer	9	13
10. Immunologic	Prior Steroid Use	2	3	No Data	--	--	Prior Steroid Use Immunocompromised Prior Splenectomy	6	9	Prior Steroid Use Lupus Immunocompromised	2	2	Prior Steroid Use	3	4
11. Hematologic	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	8	12	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	5	8	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20 Admission % polys >= 90 Admission % bands >= 15	38	44	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	4	5	Admission Hematocrit < 30 Admission Hemoglobin < 10 Admission WBC > 20	11	12
12. Musculoskeletal	Partially/totally nonambulatory Difficulty with limbs	23	28	Difficulty with limbs	6	8	Partially/totally nonambulatory	26	34	Partially/totally nonambulatory	21	26	All patients	100	100
13. Nutrition	Admission Albumin <= 3.0	7	8	Admission Albumin <= 3.0	2	4	Malnourished Admission Albumin <= 3.0	25	33	Malnourished Admission Albumin <= 3.0 Morbidly obese	9	9	Cachetic Admission Albumin <= 3.0	12	10

Table B.16

NUMBER OF BODY SYSTEM PROBLEMS NOTED AT ADMISSION ACROSS DISEASES

Number of Body System Problems	CHF				AMI				PNE				CVA				HIP			
	Pre (n=1359)		Post (n=1465)		Pre (n=1416)		Post (n=1437)		Pre (n=1341)		Post (n=1408)		Pre (n=1382)		Post (n=1442)		Pre (n=1358)		Post (n=1404)	
	%	% Cum	%	% Cum	%	% Cum	%	% Cum	%	% Cum	%	% Cum	%	% Cum	%	% Cum	%	% Cum	%	% Cum
1	16	16	14	14	32	32	25	25	10	10	8	8	10	10	7	7	20	20	17	17
2	31	48	27	42	38	70	36	61	18	27	15	23	30	40	24	32	28	48	26	43
3	27	75	28	70	20	90	23	84	25	52	19	42	30	69	32	64	25	74	26	69
4	16	91	18	87	8	98	11	95	19	72	22	64	19	87	22	86	18	91	20	88
5	6	97	9	96	2	100	3	99	15	86	16	79	8	96	10	96	6	97	8	96
6	2	100	2	98	0	100	1	100	9	95	13	92	4	99	3	99	2	100	3	99
7	0	100	1	100	0	100	0	100	4	99	6	98	1	100	1	100	0	100	1	100
8	0	100	0	100	0	100	0	100	1	100	2	100	0	100	0	100	0	100	0	100
9	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100

CHF 18:40 8/09/88 NV
AMI 21:15 2/15/89 JK
PNE 18:16 12/22/88 NV
CVA 18:00 1/17/89 NV
HIP 28:23 1/04/89 NV

Table B.17

AMI NORRIS CORONARY PROGNOSTIC INDEX
(pre-PPS compared with post-PPS)

	Code	Score	% of Pre Patients (n=1416)	% of Post Patients (n=1437)
Age				
>= 80	1	3.9	25.7	28.1
70-79	2	3.1	48.2	50.0
< 70	3	2.3	26.1	21.9
MI location/extent (1)				
MD: anterior & inferior	1	3.0	0.8	1.3
MD: anterior	2	2.8	27.8	26.9
MD: inferior	3	2.0	25.6	24.1
MD: transmural but location unspecified	4	2.0	9.2	9.3
MD: subendocardial	5	0.84	14.3	17.8
EKG: anterior	6	2.8	1.2	1.1
EKG: inferior	7	2.0	0.9	1.1
EKG: transmural but location unspecified	8	2.0	0.1	0.1
EKG: subendocardial	9	0.84	1.0	1.1
EKG: no evidence of MI	10	0	14.0	11.8
No EKG	M	0	5.0	5.4
Systolic blood pressure on admission				
< 55	1	10	0.6	0.6
55-64	2	7	0.8	0.7
65-74	3	6	0.6	0.8
75-84	4	5	1.4	2.5
85-94	5	4	3.0	2.7
95-104	6	3	4.6	5.2
105-114	7	2	7.1	7.9
115-124	8	1	9.9	11.1
>= 125	9	0	71.5	68.1
No measurement on admission	M	0	0.6	0.4
Cardiomegaly by CXR				
Yes	1	1.1	41.9	45.7
No	0	0	49.5	47.0
No CXR D1H or D2H	M	0	8.6	7.3
Pulmonary Congestion				
Severe CHF by CXR	1	3.3	7.5	8.7
Moderate \027F by CXR	2	2.0	8.8	9.9
Mild CHF by CXR	3	1.0	18.5	17.0
Lungs not clear.MD exam and unlikely or no CHF by CXR	4	1.0	23.4	24.6
History of Ischemia				
Prior angina or prior MI	1	0.4	44.6	48.8

AMI: 3/10/89, 11:49, JK

(1) Defined by an MD review. If the MD did not identify an MI (codes 1-5), the MI location as described on the EKGs report on days 1 or 2 was used.

Table B.18

AMI: KILLIP MI SEVERITY
(pre-PPS compared with post-PPS)

	% of Pre-PPS Patients (n=1416)	% of Post-PPS Patients (n=1437)
MD identifies shock D2H or SBP < 90 D1H or D2H	22.7	28.5
Severe CHF by CXR D1H or D2H	6.0	7.5
Moderate or mild CHF by CXR D1H or D2H	20.8	19.0
Unlikely or no CHF by CXR D1H or D2H	44.0	40.4

Table B.19

GOLDMAN CARDIAC RISK INDEX
Pre-PPS versus Post-PPS

	Pre-PPS			Post-PPS		
	Distribution of Patients (n=1358)		Mortality	Distribution of Patients (n=1404)		Mortality
	n	%	%	n	%	%
Goldman Score Day 1,2 (All Patients, regardless of surgery)						
0-9	860	63.3	3.8	875	62.3	2.3
10-16	393	28.9	6.9	409	29.1	5.9
>= 17	105	7.7	10.5	120	8.6	5.0
All	1358	100	5.2	1404	100	3.6
Goldman Score Day 1,2 (Only Patients with Surgery)						
0-9	799	63.2	3.4	835	63.2	2.3
10-16	373	29.5	5.6	374	28.3	4.0
>= 17	93	7.3	8.6	113	8.6	3.5
All	1265	100	4.4	1322	100	2.9
Goldman Score Day 1,2 (Only Patients with No Surgery)						
0-9	61	65.6	9.8	40	48.8	2.5
10-16	20	21.5	30.0	35	42.7	25.7
>= 17	12	12.9	25.0	7	8.5	28.6
All	93	100	16.1	82	100	14.6
Goldman Score Immediately Prior to Surgery (Only Patients with Surgery)						
0-9	813	64.3	3.3	869	65.7	2.6
10-16	364	28.8	5.8	350	26.5	3.1
>= 17	88	7.0	9.1	103	7.8	3.9
All	1265	100	4.4	1322	100	2.9

HIP: 01/04/89, 18:23, NV

Appendix C

FURTHER DETAILS ON MEASURING EXPLICIT PROCESS OF CARE

Appendix C provides background material about the model used for developing explicit process criteria and about how explicit process measures were analyzed. The appendix also lists the disease-specific explicit process criteria for each disease and the compliance found with these criteria, compares the performance on process criteria across diseases for the pre- and post-PPS sample combined, compares the performance on process criteria across diseases for the pre-PPS versus the post-PPS sample, provides background material about the model used for developing scales from the explicit process criteria, and lists the performance for each disease on process scales.

DEVELOPING PROCESS CRITERIA

Process of care refers to medical care activities delivered to patients by physicians, nurses, or technicians. Hospital-based processes of care can be divided into diagnostic and therapeutic categories. Each of these can be further divided into cognitive and technical processes.

The function of diagnostic processes is to accumulate more data about the patient in an attempt to develop a precise therapeutic plan that would improve patient outcome. Examples of diagnostic cognitive processes include physician and/or nurse assessment of whether the patient has shortness of breath or confusion. Diagnostic technical processes include ordering X-rays, electrocardiograms, and laboratory studies. Placing patients in the ICU is diagnostic in that ICU placement increases the number of physician and nurse observations per patient. It may be considered both a cognitive and technical process.

Therapeutic processes are designed to improve patients' experiences and outcomes. Therapeutic cognitive processes in hospital-based acute care medicine include patient counseling and physical therapy. Therapeutic technical processes include use of oxygen therapy, medications, and surgery.

Each process can occur on any hospital day and the appropriateness of the process can and should be assessed in relation to when it was performed. For example, one can assess the use of telemetry or the ICU in the initial, mid, or terminal part of the hospital stay. Process measures should be performed in a timely fashion depending upon the urgency of the patient's need. Some process measures must be performed on a certain day to be appropriate; other process measures can take place at any time during the hospital stay. Table C.1 shows the way process can be measured throughout the days of the hospital stay for diagnostic and therapeutic services.

All process measures are conditional if-then statements. We can consider measures applicable to all patients, conditional on patients being hospitalized with that disease. For example, *all patients hospitalized with congestive heart failure* should have a physician lung exam on each day. Measures applicable to subsets of patients must define the subset in the conditional statement. For example, only *very sick patients* should use the ICU or receive pressors.

Table C.1

MEASURING PROCESSES THROUGHOUT THE DAYS OF THE HOSPITAL STAY

Use of Services	Initial Assessment of all Patients Day 1 or 2	Initial Management of all Patients Day 1 or 2	Assessment of Subsets of Patients >= Day 3	Management of Subsets of Patients >= Day 3	Assessment of Patients with Adverse Outcome >= Day 3	Management of Patients with Adverse Outcome >= Day 3	Assessment Day Before or Day of Discharge	Management Day Before or Day of Discharge
Diagnostic services								
MD cognitive services								
RN cognitive services								
Venous blood tests								
Arterial blood tests								
X-ray								
EKG								
Microbiology								
Pathology								
Cardiac monitoring								
Monitoring procedures								
Therapeutic services								
Meds								
Oxygen								
Ancillary services (e.g., physical, respiratory therapy)								
RX procedures (e.g., surgery)								

Developing Abstraction Forms

To measure quality of care, we used a number of criteria for developing process measures. First, we sought process measures that could be reliably studied using the medical record as a data base. To assess whether suggested process measures were reliably documented in the medical record, we pilot tested process measures using 50–75 medical records for each disease. The records were selected from 1981 to 1986, from a mixture of hospital types in each of the five study states. We studied whether both the *if* and the *then* components of the process measures were reliably found within the record.

For example, our pilot data demonstrated that items such as use of ICU or medications were reliably recognizable from the record. In contrast, the number of times a frail patient was moved from the bed to a chair for upright posture and conditioning was not easily measured from the record and was not included as a process measure. The time it took for a nurse to respond to a bedridden patient's call and the adequacy of nutrition were also important. However, these processes are difficult to measure using the medical record and we did not assess them.

Second, we sought process measures that were clinically valid. We began this process with literature review and consultation with subspecialist and generalist experts. We specifically asked the experts to define process measures they believe make a difference in patient outcome. After listing such process measures, the research team selected a subset that were likely to be measurable from the medical record. These measures were presented to disease-specific panels consisting of 5–12 PRO-selected physicians. Table C.2 shows physician specialty types selected for each of the study diseases.

At these panel meetings, RAND physician researchers, 1–2 UCLA subspecialty consultants, and PRO physicians reviewed the suggested criteria to evaluate whether as a group they believed these criteria were likely to be reliably recorded in the medical record and whether the process criteria made clinical sense. Specifically, we asked how important they thought each measure was as a process criterion. We paid particular attention to physicians' comments that suggested variations in recording of process by year, state, and/or hospital type. We finally included as process measures only those that the physician panel believed were reliably recorded and clinically important in determining outcomes. We selected

Table C.2

DISEASE-SPECIFIC PHYSICIAN SPECIALTY PANELS

Disease	Physician Specialty	Number of Physician Participants
Acute myocardial infarction	Cardiology	12
Congestive heart failure	Internal medicine	12
Hip fracture	Orthopedics	7
Pneumonia	Pulmonology	5
Cerebrovascular accident	Neurology	5
Depression	Psychiatry	5

process measures that the panelists believed could discriminate excellent, good, adequate, poor, and very poor medical care in any area of the country from 1981 through 1986.

Third, we selected process measures that involved reasonably stable technologies from 1981 to 1986. We did not develop process criteria that would penalize 1981 process scores for using technologies such as angioplasty or thrombolytic therapy that were less available during the early part of the decade.

Fourth, we collected items that could be abstracted from the medical record within a few minutes, since the amount of time for complete record abstraction was fixed at an average of 75 minutes per record for this study. Given the fixed time for abstraction, we did not attempt to measure every inhospital process. Instead, we selected process measures to represent categories of process. We developed some process measures that would apply to all diseases. In addition, for each disease we studied some aspect of process in more detail than for other diseases. Table C.3 shows categories of process studied for each disease.

Fifth, we developed process measures that were applicable to a large number of patients, since the cost of data collection is significant.

Table C.3

CATEGORIES OF PROCESS MEASURES FOR EACH DISEASE

Use of Services	CHF	AMI	HIP	PNE	CVA	DEP
Diagnostic services						
MD cognitive assessment	X	X	X	X	X	X
RD cognitive assessment	X	X	X	X	X	X
Venous blood tests	X	X	X	X	X	X
Arterial blood tests	X	X	X	X	X	X
X-ray	X	X	X	X	X	X
EKG	X	X	X	X	X	X
Microbiology	X		X	X		
Pathology						
Cardiac monitoring	X	X	X	X	X	X
Monitoring procedures		X				
Therapeutic services						
Meds	X	X	X	X	X	X
Oxygen	X	X	X	X	X	
Ancillary services (e.g., physical respiratory therapy)			X	X	X	X
RX procedures (e.g., surgery electro-convulsive therapy)		X	X		X	X

The final set of process data collected from the medical record was based on views of the physician panelists and those of the research team. We combined clinical judgment with expertise in what is measurable from the medical record. The instruments used for measuring process have been published elsewhere (Kahn et al., 1988b; Kosecoff et al., 1988; Roth et al., 1988; Rubenstein et al., 1988; Sherwood et al., 1988; Wells et al., 1988).

Defining Process Measures for Subsets of Patients

Using the disease-specific panel meetings, we collected data about patients' conditions (or sickness levels) throughout the hospital stay. In addition, we collected data about use of services. Each process measure was designed to be specific for a patient's sickness. The process criteria do not necessarily consider more process as better. Instead, the criteria rate more appropriate process as better. For example, use of antibiotics is considered good care only if a clear therapeutic or prophylactic indication exists.

To develop clinically valid process measures, both the *if* and the *then* part of the process statement must be defined. To define the *if* part of the conditional process statement, we are obligated to define the group of sick patients for whom specific interventions are appropriate. *Then* conditional statements measure whether a process was or was not performed. When *if* can be precisely defined (e.g., bacteremia) and *then* (e.g., use of appropriate antibiotics) improves outcome, the conditional if-then statement is generally accepted in clinical practice and can provide the basis for measuring quality of care. In practice, clinicians are sometimes faced with patients with single and specific problems (e.g., bacteremia) and can respond to simple process criteria such as, "*if* bacteremia, *then* use antibiotics." More often, however, during hospital-based acute care medical practice (especially for the elderly) clinicians are faced with a combination of symptoms and signs that characterize the patient as sick.

Clinicians recognize at the bedside the patient who requires diagnostic and/or therapeutic interventions because that patient is generally sick and unstable. The clinician gauges the type, number, and timing of interventions (*then* statements) according to the severity of the patient's sickness (*if* statements). As the number of abnormal symptoms and signs increases, the clinician generally becomes increasingly concerned with the patient and generally is obligated to make more diagnostic and therapeutic interventions. For example, if a patient shows new distress (e.g., shortness of breath or chest pain) or unstable vital signs (e.g., tachycardia or tachypnea) the clinician recognizes that an intervention should be made. When the clinician notes a combination of these problems, the clinician generally makes the interventions more urgent and comprehensive. If the problem is new, the clinician is even more aggressive with diagnostic and therapeutic interventions.

Defining Sickness for Subsets of Patients

In designing a system for measuring quality of care for sick patients, we faced the challenge of objectively defining sickness for the *if* part of conditional if-then statements. Should sickness be defined by symptoms, signs, or both? Which symptoms or signs are the best measure of sickness? How do symptoms and signs combine to determine degrees of sickness? Does the importance of symptoms and signs vary by disease? To answer these questions we developed a new method for defining patient sickness and validated it clinically.

For each patient hospitalized with congestive heart failure, acute myocardial infarction, hip fracture, pneumonia, and stroke, we collected data about some or all of the following variables: shortness of breath (presence or absence), chest pain (presence or absence), confusion (presence or absence), heart rate ≥ 130, respiratory rate ≥ 30, systolic blood pressure < 90, and diastolic blood pressure ≥ 105. We considered patients as having shortness of breath, chest pain, or confusion if the physician and/or nurse described the symptom in the record for the day under examination. Vital signs were abstracted from graphic sheets, ICU flow sheets, and nurses notes.

For congestive heart failure, acute myocardial infarction, hip fracture, pneumonia, and cerebrovascular accident we collected data about heart rate, respiratory rate, systolic blood pressure, and diastolic blood pressure.

For congestive heart failure and pneumonia, we had a trichotomous variable for shortness of breath. That allowed us to distinguish the presence of shortness of breath from its absence, and from no data for each hospital day studied. For acute myocardial infarction we used a trichotomous variable for chest pain that allowed us to distinguish the presence and absence of chest pain from no data about chest pain that day. All other variables were dichotomous (yes versus no/no data). We considered patients confused only if they did not have a history of dementia, except for hospital day 1 on which dementia was not considered.

For cerebrovascular accident, we collected data about the same variables listed above except for chest pain and confusion. For hip fracture, we collected data only about signs, not about symptoms. For each variable, we asked data collectors to indicate the patients' worst status for the day. For example, if the systolic blood pressure was < 90 on only one of several readings that day, we considered systolic < 90 that day.

We used logistic regression on our dataset to determine the value of each of the symptoms and signs in predicting inhospital mortality. For congestive heart failure and acute myocardial infarction, we validated the logistic weights on a separate dataset of 1,500 patients for each disease collected for the Nonintrusive Outcome Study (NOS). The NOS sample was designed to have a 50 percent mortality. NOS oversampling on mortality differed from the current study sample that randomly selected patients based on diagnosis, regardless of outcome.

After studying the relationship between abnormal symptoms and signs and inhospital mortality, we developed a sickness scale that categorized patients according to the presence or absence of a combination of symptoms and signs. We named the scale ASSC, the acronym for Any Symptom or Sign Complex. Patients were assigned increasing ASSC points in relation to the number and type of each of the following symptoms and signs: shortness of breath, chest pain, confusion, heart rate ≥ 130, respiratory rate ≥ 30, systolic blood pressure < 90, and/or diastolic blood pressure ≥ 105. Table C.4 shows the relationship of ASSC scores to death for each disease.

We developed a series of process criteria defining subsets for *if* conditional statements. When possible, we used specific conditional *if* statements (e.g., *if* febrile; *if* life-threatening potassium value). To identify generally sick and unstable patients, we used the generic ASSC measure of sickness. Table C.5 defines our clinical definitions of ASSC categories.

Timing of Process Measures

We categorized process measures according to when, during the hospital stay, the criteria should be met. We defined the initial hospital stay as the first two days. We studied day 3 processes for study diseases as a sample of subsequent hospital days. For all six study diseases we collected data on the day before discharge and day of discharge. For some process measures (e.g., fever > 101°F or 38.3°C), we collected process data regardless of when

Table C.4

MORTALITY RATES STRATIFIED BY ASSC
(in percent)

	CHF	AMI	PNE	CVA	CHF	AMI	PNE	CVA
	Initial Score				Day 3 Score			
ASSC score								
0	0	0	2	9	4	5	3	11
1	6	8	3	17	5	8	4	16
2	4	11	3	28	9	19	10	37
3	10	15	9	46	12	24	17	42
4	8	19	3	54	20	24	24	54
5	16	25	20	65	29	30	31	62
6	16	34	23	76	48	39	50	41
≥7	32	57	48	90	50	68	69	44

	HIP Initial Score	HIP Day 3 Score
ASC score		
0	3	3
1	5	4
2	7	11
≥3	17	9

during the hospital stay the *if* component of the conditional process measure occurred. For example, for CHF patients, *if* temperature > 101°F (38.3°C), *then* at least one fever work-up should take place regardless of when during the hospital stay the fever occurred.

Because of the cost of data collection, we were unable to collect clinically detailed data about every process measure for each hospital day. Although we collected data about use of some services (e.g., ICU and telemetry) for every hospital day, we were able to define the need for those services only for a sample of days. We elected to supplement process measures on initial, subsequent (i.e., day 3), and discharge days with process measures around the time a patient became very sick. Specifically, for four study conditions (CHF, AMI, HIP, PNE) we selected a group of very sick patients. We categorized patients as very sick if they sustained an adverse outcome. Disease-specific adverse outcomes are defined in Table C.6. We then collected clinically detailed data from the medical record about process measures delivered on the days before and on the day of the adverse outcomes for these very sick patients. This data collection was designed to assess the preventability of the adverse outcome. We also collected data about the patients' status during the days following the adverse outcome to assess whether it was appropriately diagnosed and treated. For CHF, AMI, and PNE, we

Table C.5

CLINICAL DEFINITIONS OF ASSC

	ASSC Score Values				
Sickness Category	CHF(1)	AMI(1)	HIP(2)	PNE(1)	CVA(3)
Not very sick	0-2	0-2	0-1	0-2	0
Somewhat sick	3-4	3-4	2	3-4	1
Moderately sick	5-6	5-6	≥ 3	5-6	2-3
Very sick	≥ 7	≥ 7		≥ 7	≥ 4

[1] ASSC variables for CHF, AMI, and PNE include: shortness of breath (1), chest pain (1), confusion (2), heart rate ≥ 130 (2), respiratory rate ≥ 30 (2), systolic < 90 (3), diastolic ≥ 105 (1). Numbers in parentheses are the points assigned for the presence of each variable.

[2] Variables for HIP include: heart rate ≥ 130 (2), respiratory rate ≥ 30 (2), systolic < 90 (3), diastolic ≥ 105 (1). Numbers in parentheses are the points assigned for the presence of each variable.

[3] Variables for CVA include: shortness of breath (1), heart rate ≥ 130 (2), respiratory rate ≥ 30 (2), systolic < 90 (3), diastolic ≥ 105 (1). Numbers in parentheses are the points assigned for the presence of each variable.

studied the five days surrounding each patient's first adverse outcome. For HIP, we studied the day before and day of each patient's first adverse outcome.

Table C.7 demonstrates the time periods for process-related data collection for each of six study diseases.

ANALYZING PROCESS MEASURES

We used clinical judgment to assign points to each process measure according to how important we believed each process was in determining outcomes. The basis for clinical judgment was literature review and clinical experience. In assigning points, the clinician researchers were blind to differences in the use of services during the pre- and post-PPS periods.

The major challenge in scoring process measures was to assign "good" process points only for the meeting of clinically important and relevant process criteria. The use of more

Table C.6

DEFINITIONS OF ADVERSE OUTCOMES

Definitions of Adverse Outcomes	CHF	AMI	HIP	PNE	CVA(1)	DEP(1)
Seizure, syncope, or loss of consciousness on day 2 or later	X		X	X		
Shock on day 2 or later	X	X	X	X		
Coma on day 2 or later	X		X	X		
Arrest (except in ER)	X	X	X	X		
Death	X	X	X	X		
Recurrent chest pain day 3 or later (on ≥ 2 consecutive days)		X				
Endotracheal or nasotracheal intubation (except in ER)			X	X		

[1] For cerebrovascular accident and depression, process measures were not specifically collected around the adverse outcome.

services should earn more process points, only if those additional services were clinically indicated.

We attempted to develop a scoring system that would score only appropriate process and that would take account of the number and importance of process measures applicable to each patient according to their level of sickness.

ASSIGNING PROCESS POINTS FOR PROCESS CRITERIA

For every process criterion, we used clinical judgment to determine the maximum number of points that could be achieved when the patient was optimally treated. This was the number of "applicable" points for that criterion. For example, for a very sick patient (e.g., ASSC ≥ 7) who should be in the ICU on a particular day, we assigned 7 "applicable" or potential points for the process criteria related to ICU use that day.

We also designated "assigned" process points to characterize care that was actually given to the patient. If the patients received optimal care, then their "assigned" points would equal their "applicable" points. For example, the patient monitored in the ICU would receive

Table C.7

HOSPITAL DAYS WHEN PROCESS DATA WERE COLLECTED

	CHF	AMI	HIP	PNE	CVA	DEP
Initial days (i.e., day 1 and 2)	X	X	X	X	X	X
Day 3	X	X		X	X	X
Days around first adverse outcome(1)	X	X	X	X		
Days around surgery			X			
Discharge days (i.e., day before and day of discharge)	X	X	X	X	X	X
First time problem occurs regardless of day (i.e. life threatening lab, fever)	X	X	X	X	X	X

[1] For CHF, AMI, and PNE we studied two days before the adverse outcome day, the adverse outcome day, and two days after the adverse outcome day. For HIP we studied the day before and day of the adverse outcome.

7 “assigned” points from a possible 7 “applicable” points and receive 100 percent of the possible process points for monitoring that day.

Since patients did not always receive optimal care, we used clinical judgment to assign points for less than optimal strategies. For example, for CHF, if telemetry rather than ICU were used to monitor a very sick patient (e.g., ASSC ≥ 7), then only 3 “assigned” of a possible 7 “applicable” points would be given (43 percent). If the patients received neither telemetry nor ICU monitoring, then they would receive 0 “assigned” of 7 “applicable” ICU monitoring points (0 percent).

In developing scores for process criteria, we attempted to maintain consistency across diseases and within diseases. For example, if a patient were very sick and would likely benefit from ICU monitoring, we assigned 7 points across diseases. We assigned 1 point for each blood chemistry test across diseases. We assigned 2 points for ordering an electrocardiogram to rule out a myocardial infarction and assess rhythm in a very sick patient admitted with CHF.

We adjusted the relative number of applicable points assigned according to how important clinician judgment suggested it was for a criterion to be met and according to how likely the data demonstrated the criterion was to be met. Clinical judgment suggests that ICU monitoring is important for sick patients. This is reflected in the process criteria: If sick, the patient should have ICU monitoring.

We adjusted scores for process criteria according to the clinically expected benefit of using the services for subsets of patients. Table C.8 shows scores for use of ICU and telemetry for different categories of CHF patients classified by sickness (i.e., ASSC score). The maximum number of "applicable" points drops as the clinical benefit to the patient is expected to drop. For very sick patients, 7 applicable process points are assigned; this number of applicable points drops to 3 for moderately sick patients, and to 0 for other patients.

The scores also take into account the differential value of ICU versus telemetry for patients with different sickness levels. Very sick patients receive 42 percent of applicable points (3 of 7) for using telemetry, whereas moderately sick patients receive a higher fraction (67 percent) of applicable points for telemetry monitoring. This type of scoring emphasizes

Table C.8

ASSIGNED AND APPLICABLE POINTS FOR ICU AND TELEMETRY MONITORING FOR CHF PATIENTS STRATIFIED BY SICKNESS

Clinical ASSC Definition	ASSC Score	Type of Monitoring Used	Assigned Points	Applicable Points	% Assigned/ Applicable Points
Very sick	7	ICU or CCU	7	7	100
		Telemetry	3	7	0.42
		None	0	7	0.00
Moderately sick	5-6	ICU or CCU	3	3	1.00
		Telemetry	2	3	0.67
		None	0	3	0.00
Somewhat sick	3-4	ICU or CCU	0	0	0.00
		Telemetry	0	0	0.00
		None	0	0	0.00
Not very sick	2	ICU or CCU	0	0	0.00
		Telemetry	0	0	0.00
		None	0	0	0.00

NOTE: CHF process criteria: On day 1 of hospitalization for CHF if the patient is very sick (i.e., ASSC > = 7), the ICU should be utilized. Telemetry is not sufficient but is preferable to no cardiac monitoring. On day 1 of hospitalization for CHF, if the patient is moderately sick (i.e., ASSC 5-6), the ICU or telemetry should be used.

clinical logic. For very sick patients the difference between ICU use and telemetry use is valued more highly than the difference for less sick patients. Also the difference between using ICU and no monitoring is greater for very sick than for less sick patients.

For this and other process measures we examined the empirical frequency with which the criteria were met for subsets of patients. Table C.9 shows the use of the ICU and telemetry for CHF patients according to level of sickness. The table shows that 67 percent of very sick (i.e., ASSC ≥ 7) CHF patients use the ICU and 40–50 percent of moderately sick (i.e., ASSC 5–6) CHF patients used the ICU. In contrast, only 23–39 percent of mildly sick patients (i.e., ASSC 3–4) and less than 23 percent of not very sick patients (i.e., ASSC ≤ 3) used the ICU.

We further validated the process criteria by studying mortality rates for patient subsets. If the mortality increased as sickness increased (e.g., as it did for increasing values of ASSC—see Table C.4), then it seemed reasonable to expect that more services would be used to diagnose (e.g., with laboratory studies) and treat (e.g., with pressors) the patient.

Table C.10 discusses the power of the study design to detect differences in care pre- versus post-PPS. Clinically meaningful disease-specific pre- versus post-PPS differences *at the level of a single process item that apply only to a small fraction of patients* may not show up as significant in our data, even with about 2,800 patients per disease (Table C.10).

For example, a pre- versus post-PPS difference in percentage of patients meeting a disease-specific criterion that applies to only 25 percent of patients and that was met by 70 percent of patients in the pre-PPS period would have to be at least 7 percentage points to show up as significant at the usual 5 percent level, i.e., a pre-post change from 70 to 75 percent compliance would not be significant for such an item but a change from 70 percent to 80 percent would be significant.

For this reason, we did not draw process conclusions at an item-specific level. Tables like the one above are precisely why we built scales consisting of weighted sums of individual items: The scale will be much more sensitive than any of the items making it up. As we document in Sec. II, if our final composite process scale is rescaled to have a range from 0 to 100 and a standard deviation of 10, and if our design gave us at least 80 percent power to find pre- versus post-PPS differences of only 1.1 points at the disease-specific level, we had power to detect even small process differences associated with the introduction of PPS.

The main negative process finding was our inability to demonstrate a process-outcome link for hip fracture, with outcome measured by 30-day death and process measured by our composite scale. We again do not believe that this was due to insufficient power, for the following reason. We assessed the significance of our process-outcome links in each disease by logistically regressing 30-day death on the composite process scale and our scale measuring sickness at admission, and examining the significance of the process coefficient. It is difficult to make explicit power calculations with logistic regression coefficients, but a close approximation can be obtained by examining the corresponding coefficient from the ordinary least squares regression of the 0–1 death indicator on process (for simplicity the admission sickness variable is omitted from these calculations; the results would be similar if it were included). It is straightforward to show that the correlation between the 0–1 death indicator y and the composite process score χ is

$$r = \frac{(\bar{\chi}_1 - \bar{\chi}_0)}{s\chi}\sqrt{p(1-p)}\,,$$

Table C.9

DISTRIBUTION OF CHF PATIENTS BY USE OF ICU AND TELEMETRY STRATIFIED BY ASSC VALUES ACROSS HOSPITAL DAYS

ASSC Score	Hospital Day	n	ICU %	Telemetry %	ICU or Telemetry %
0	1	31	6	10	16
1	1	726	11	21	32
2	1	481	23	27	51
3	1	555	23	22	46
4	1	410	39	21	61
5	1	263	40	15	56
6	1	189	50	18	68
>= 7	1	159	67	15	82
0	3	977	17	21	38
1	3	794	18	25	43
2	3	329	26	24	50
3	3	327	27	24	51
4	3	107	35	27	62
5	3	90	39	21	60
6	3	44	52	16	68
>= 7	3	48	69	12	81
0	AO	29	11	30	41
1	AO	27	12	16	28
2	AO	47	36	13	49
3	AO	82	21	23	44
4	AO	44	33	36	69
5	AO	66	32	21	52
6	AO	56	50	13	63
>= 7	AO	90	69	13	82

AO Day of Adverse Outcome.

Table C.10

MINIMUM SIGNIFICANT DISEASE-SPECIFIC ITEM-LEVEL DIFFERENCES IN PROCESS SCORES PRE- VERSUS POST-PPS
(In percent)

% of Pre-PPS Patients Meeting Criteria	% of Patients Applicable				
	100	75	50	25	10
50	3.8	4.4	5.4	7.6	12.0
40 or 60	3.7	4.3	5.2	7.4	11.7
30 or 70	3.5	4.0	4.9	7.0	11.1
20 or 80	3.0	3.5	4.2	6.0	9.5
10 or 90	2.3	2.7	3.2	4.6	7.3
5 or 95	1.6	1.8	2.3	3.2	5.0

where $\bar{\chi}_1$ and $\bar{\chi}_0$ are the mean process scores for patients who died and lived, respectively, s_χ is the standard deviation of the process scores, and p is the fraction of patients who die within 30 days of admission with the given disease. With 2,541 hip fracture patients for whom accurate postdischarge mortality information was available, the smallest such correlation r that would have shown up as significant (i.e., 2 standard errors) is about -0.04, using Fisher's approximate transformation to normality

$$z = \ell n\left(\sqrt{\frac{1+r}{1-r}}\right) .$$

For hip fracture p was about 0.049, so that the process-outcome link would have shown up as significant if *average process for hip fracture patients who died was lower than average process for patients who lived by* 0.18 *or more standard deviations*. In fact, as Table C.11 indicates for hip fracture patients

$$\frac{(\bar{\chi}_1 - \bar{\chi}_0)}{s_\chi} = +\,0.08 \ ,$$

with a 95 percent confidence interval of (-0.10 to + 0.26). The data do not exclude a small process-outcome link, which we might have found with a large sample. This result might also have been caused by our measurements of process and outcome. A better outcome for hip fracture would probably have been functional status several months after discharge, which we were not able to measure. Additionally the evaluation of process for surgical diseases may not be as accurate as for medical diseases because of limitations of data in the medical record (important intra-operative information may be particularly lacking, for example). As we discuss in Sec. IV, methods for better evaluation of surgical processes of care are needed.

EXPLICIT PROCESS CRITERIA FOR EACH DISEASE

Tables C.12 through C.16 list the explicit process criteria for each of the five study diseases. The tables are organized into four columns. The columns labeled "if" specify the group of patients to whom the criteria are applicable. The columns labeled "then" specify the criteria to be met for the relevant subset of patients. The third column specifies the percentage of patients to whom each criterion is applicable. For example, a criterion states, "within the initial two days of hospitalization, the physician should document information about medication use immediately before admission for all patients with congestive heart failure."

In contrast, the criterion of ordering a cardiac enzyme study (e.g., CPK) on day 1 or 2 of the hospitalization is applicable only to the 26 percent of patients who are moderately or very sick (i.e., ASSC ≥ 5) on day 1 or 2.

The fourth column shows the percentage of patients with applicable criterion who actually met the criterion for the pre- and post-PPS sample combined. For example, 81 percent of patients hospitalized with congestive heart failure had physician documentation about medication use immediately before admission. Of the 26 percent of patients with congestive heart failure who were moderately or very sick on day 1 or 2 of hospitalization, 67 percent met the criterion for ordering a cardiac enzyme study.

Table C.11

PROCESS DIFFERENCE (IN STANDARD UNITS) BETWEEN DEAD AND ALIVE PATIENTS, AND PROBABILITY OF DEATH, BY DISEASE

Disease	$\frac{(\bar{\chi}_1 - \bar{\chi}_0)^{(1)}}{s_\chi}$	Probability of Death within 30 Days of Admission (p)
Acute myocardial infarction	-.42	.24
Cerebrovascular accident	-.14	.21
Congestive heart failure	-.43	.14
Hip fracture	+.08	.05
Pneumonia	-.18	.16

(1) Process difference (in standard units) between patients discharged dead and alive 30 days postadmission.

Table C.12

PROCESS CRITERIA FOR CONGESTIVE HEART FAILURE

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
All patients hospitalized for CHF	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:		
	Past surgical history	100	64
	Medication use immediately before admission	100	81
	Allergy history	100	55
	Alcohol use (or non-use)	100	45
	Jugular veins examined	100	67
	Heart sounds examined	100	70
	Heart murmur examined (or not present)	100	79
	Abdomen examined	100	98
	Lower extremity examined for edema	100	91
	Lung examination day 1	100	98
	Lung examination day 2	100	64
All patients hospitalized for CHF	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:		
	Shortness of breath (presence or absence) day 1	100	90
	Shortness of breath (presence or absence) day 2	100	90
	Blood pressure assessment at least 3 times day 2	100	81
	Urinary continence (presence or absence)	100	69
	Ambulatory status	100	79
	Preadmission residence	100	94
All patients hospitalized for CHF	Within the initial two days of hospitalization, order:		
	Chest X-ray	100	95
	Electrocardiogram	100	89
All patients hospitalized for CHF	Within the initial two days of hospitalization, order each of the following laboratory studies:		
	BUN	100	90
	Creatinine	100	75
	Venous bicarbonate	100	83
	Sodium	100	95
	Potassium	100	95
	White blood count	100	93
	Hematocrit or hemoglobin	100	93
Patients moderately or very sick (i.e., ASSC >= 5) day 1 or 2	Order cardiac enzyme study day 1 or 2 (e.g., CPK)	26	67
Patients moderately or very sick (i.e., ASSC >= 5) day 1 or 2	Obtain arterial blood gas day 1 or 2	26	75

Table C.12 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients moderately sick (i.e., ASSC 5-6) day 1	Use the intensive care unit day 1 or Use telemetry day 1	16	44 ICU 16 Telemetry
Patients moderately sick (i.e., ASSC 5-6) day 2	Use the intensive care unit day 2 or Use telemetry day 2	7	45 ICU 23 Telemetry
Patients very sick (i.e., ASSC >= 7) day 1	Use the intensive care unit day 1 Telemetry is not sufficient but is preferable to no cardiac monitoring day 1	6	67 ICU 15 Telemetry
Patients very sick (i.e., ASSC >= 7) day 2	Use the intensive care unit day 2 Telemetry is not sufficient but is preferable to no cardiac monitoring day 2	2	65 ICU 17 Telemetry
Patients are hypoxic (i.e., pO2 < 60) on day 1	Use supplemental oxygen therapy or intubate day 1	18	90
Patients are hypoxic (i.e., pO2 < 60) on day 2	Use supplemental oxygen therapy or intubate day 2	4	91
Patients are moderately or very sick (i.e., ASSC >= 5) day 1 and day 2 and arterial blood gases were not evaluated on either day	Use supplemental oxygen therapy or intubate day 1 or 2	1	94
All patients hospitalized with CHF except those with systolic BP < 90 day 1 and 2	Use loop diuretic and/or digitalis day 1 or 2	92	95
All patients hospitalized for CHF	On hospital day 3, the physician should document each of the following in the medical record:		
	Shortness of breath (presence or absence) Lung examination	100 100	50 64
All patients hospitalized for CHF	On hospital day 3, the nurse should document in the medical record:		
	Shortness of breath (presence or absence)	100	88
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order a chest X-ray on day 3 Order an electrocardiogram on day 3	7 7	35 38
Patients somewhat sick (i.e., ASSC 3-4) on day 3	Order at least 3 of 7 venous blood studies on day 3. (e.g., venous bicarbonate, creatinine, BUN, sodium, potassium, white blood count, hematocrit)	16	47

Table C.12 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order each of the following venous blood tests (e.g., venous bicarbonate, creatinine, BUN, sodium, potassium, white blood count, hematocrit)	7	15
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order a cardiac enzyme study (e.g., CPK) day 3	7	23
Patients moderately or very sick (i.e., ASSC >=5) on day 3	Obtain an arterial blood gas day 3	7	41
Patients moderately sick (i.e., ASSC 5-6) on day 3	Use the intensive care unit day 3 or Use telemetry day 3	5	43 ICU 19 Telemetry
Patients very sick (i.e., ASSC >= 7) on day 3	Use the intensive care unit day 3 Telemetry is not sufficient but is preferable to no cardiac monitoring day 3	2	69 ICU 12 Telemetry
Patients are hypoxic (i.e., p02 < 60) on day 3	Use supplemental oxygen therapy or intubate day 3	3	94
All patients hospitalized for CHF except those with systolic BP < 90 day 3	Use loop diuretic or digitalis day 3	94	92

NOTE: ASSC (Any Symptom or Sign Complex) for patients with congestive heart failure is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; chest pain, 1 point; confusion, 2 points; heart rate >= 130 beats per minute, 2 points; respiratory rate >= 30 per minute, 2 points; diastolic blood pressure >= 105 mm Hg 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table C.13

PROCESS CRITERIA FOR ACUTE MYOCARDIAL INFARCTION (AMI)

If	Then	Patients to Whom Criteria Are Applicable	Patients Meeting Process Criteria
All patients	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:		
	Previous cardiac history	100	88
	Time of onset of AMI symptoms	100	96
	Social or family history	100	64
	Medication use immediately before to admission	100	84
	Allergy history	100	59
	Alcohol use (or non-use) or smoking habits	100	63
	Jugular veins examined	100	65
	Heart sounds examined	100	79
	Heart murmurs examined (or not present)	100	84
	Abdomen examined	100	97
	Lower extremity examined for edema	100	80
	Chest pain (presence or absence) day 1	100	94
	Chest pain (presence or absence) day 2	100	67
	Lung examination day 1	100	97
	Lung examination day 2	100	67
All patients	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:		
	Chest pain (presence or absence) day 1	100	92
	Chest pain (presence or absence) day 2	100	92
	Premature ventricular contractions (PVCs) assessed day 1	100	65
	Premature ventricular contractions (PVCs) assessed day 2	100	73
	Weight day 1 or 2	100	62
	Cardiac monitor rhythm strips (at least 3 on day 1)	100	81
	Preadmission residence	100	93
All patients	Within the initial two days of hospitalization, order each of the following:		
	Chest X-ray day 1 or 2	100	92
	Electrocardiogram day 1	100	95
	Electrocardiogram day 2	100	90

Table C.13 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
All patients	Within the initial two days of hospitalization, order each of the following laboratory studies:		
	BUN	100	89
	Creatinine	100	72
	Venous bicarbonate	100	84
	Sodium	100	94
	Potassium	100	94
	White blood count	100	95
	Hematocrit or hemoglobin	100	96
All patients	Order cardiac enzyme study day 1 (e.g., total creatine phosphokinase (CPK) or lactate dehydrogenase (LDH) isoenzymes or CPK isoenzymes)	100	44 CPK of LDH isoenzymes 45 Total CPK only
All patients	Order cardiac enzyme study day 2 (e.g., total creatine phosphokinase (CPK) or lactate dehydrogenase (LDH) isoenzymes or CPK isoenzyme)	100	54 CPK or LDH isoenzyme 35 Total CPK only
Patients moderately or very sick (i.e., ASSC >=5) day 1 or 2	Obtain arterial blood gas day 1 or 2	34	71
Patients with cardiogenic shock with end organ damage, arrhythmias, and very sick (i.e., ASSC >=7) day 1	Use intensive care unit (ICU) day 1. Telemetry is not sufficient but is preferable to no cardiac monitoring	6	92 ICU 4 Telemetry
Patients with shock or very sick (i.e., ASSC >=7) day 1	Use ICU day 1. Telemetry is not sufficient but is preferable to no cardiac monitoring	16	89 ICU 7 Telemetry
Patients moderately sick (i.e., ASSC = 5-6) day 1	Use ICU day 1. Telemetry is not sufficient but is preferable to no cardiac monitoring	8	82 ICU 12 Telemetry
Patients with congestive heart failure and somewhat sick (i.e., ASSC = 3-4) day 1	Use ICU day 1. Telemetry is not sufficient but is preferable to no cardiac monitoring	8	80 ICU 12 Telemetry
Patients with congestive heart failure and not very sick (i.e., ASSC <=2) day 1	Use ICU day 1. Telemetry is not sufficient but is preferable to no cardiac monitoring	11	76 ICU 17 Telemetry

Table C.13 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients somewhat sick (i.e., ASSC =3-4) day 1	Use ICU day 1. Telemetry is not sufficient but is preferable to no cardiac monitoring	14	76 ICU 17 Telemetry
Patients not very sick but some symptom or sign (i.e., ASSC =2) day 1	Use ICU day 1 or use telemetry day 1. ICU is preferable.	19	75 ICU 18 Telemetry
Patients with AMI and one or no symptoms or signs (i.e., ASSC = 0-1) day 1	Use ICU day 1 or use telemetry day 1. ICU is preferable.	15	74 ICU 20 Telemetry
Patients with no evidence of AMI and one or no symptoms or signs (i.e., ASSC = 0-1) day 1	Use ICU day 1 or use telemetry day 1	3	62 ICU 25 Telemetry
Patients with cardiogenic shock with end organ damage, arrhythmias, and very sick (i.e., ASSC >=7) day 2	Use ICU day 2. Telemetry is not sufficient but is preferable to no cardiac monitoring	4	96 ICU 4 Telemetry
Patients with shock or very sick (i.e., ASSC >=7) day 2	Use ICU day 2. Telemetry is not sufficient but is preferable to no cardiac monitoring	13	89 ICU 8 Telemetry
Patients moderately sick (i.e., ASSC = 5-6) day 2	Use ICU day 2. Telemetry is not sufficient but is preferable to no cardiac monitoring	4	87 ICU 10 Telemetry
Patients with congestive heart failure and somewhat sick (i.e., ASSC = 3-4) day 2	Use ICU day 2. Telemetry is not sufficient but is preferable to no cardiac monitoring	3	88 ICU 7 Telemetry
Patients with congestive heart failure and not very sick (i.e, ASSC <=2) day 2	Use ICU day 2. Telemetry is not sufficient but is preferable to no cardiac monitoring	7	90 ICU 8 Telemetry
Patients somewhat sick (i.e., ASSC = 3-4) day 2	Use ICU day 2. Telemetry is not sufficient but is preferable to no cardiac monitoring	10	84 ICU 11 Telemetry

Table C.13 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients at least somewhat sick (i.e., ASSC >=3) on day 1 with or without shock and congestive heart failure but not very sick (i.e., ASSC <=2) on day 2 with or without evidence of AMI	Use ICU day 2. Telemetry is not sufficient but is preferable to no cardiac monitoring	29	77 ICU 16 Telemetry
Patients not very sick (i.e,. ASSC <=2) on day 1 with or without evidence of AMI and not very sick but some symptom or sign (i.e., ASSC = 2) day 2	Use ICU day 2 or use telemetry day 2. ICU is preferable.	4	83 ICU 13 Telemetry
Patients not very sick (i.e,. ASSC <=2) on day 1 and with AMI and one or no symptoms or signs (i.e., ASSC = 0-1) day 2	Use ICU day 2 or use telemetry day 2. ICU is preferable.	22	75 ICU 20 Telemetry
Patients not very sick (i.e,. ASSC <=2) on day 1 and with no evidence of AMI and one or no symptoms or signs (i.e., ASSC = 0-1) day 2	Monitoring day 2 in ICU or telemetry is preferable to no monitoring.	5	66 ICU 25 Telemetry
Patients with cardiogenic shock with end organ damage, arrhythmias, and very sick (i.e., ASSC >=7) day 1 or 2	Place a Swan Ganz catheter on day 1 or 2	8	34
Patients with cardiogenic shock with end organ damage, arrhythmias, and very sick (i.e., ASSC >=7) day 1	Use pressors or IV unloading agents day 1	6	74
Patients with cardiogenic shock with end organ damage, arrhythmias, and very sick (i.e., ASSC >=7) day 2	Use pressors or IV unloading agents day 2	4	75

Table C.13 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients with ventricular tachycardia (VTach) day 1	Give antiarrhythmics day 1	1	94
Patients with PVCs day 1	Give antiarrhythmics day 1	23	69
Patients with VTach day 2	Give antiarrhythmics day 2	1	70
Patients with VTach day 2	Give antiarrhythmics day 2	17	63
Patients with 3rd degree heart block day 1 or 2 and anterior MI	Use pacemaker day 1 or 2	1	77
Patients with 3rd degree heart block day 1 or 2 and no anterior MI	Use pacemaker day 1 or 2	3	62
Patients given streptokinase	Document bleeding history (presence or absence)	2	13
Patients given streptokinase	Start streptokinase within 6 hours of the time symptoms were first noted	2	69
Patients with congestive heart failure but no hypotension day 1	Give loop diuretics day 1	19	53
Patients with congestive heart failure but no hypotension day 2	Give loop diuretics day 2	9	67
Patients with hypertension (diastolic BP >= 105) persisting for day 1 and 2	Give IV unloading agents, long acting nitrates, oral or IV beta blockers, or calcium channel blockers day 2	3	67
Patients with chest pain and no IV unloading agents on day 2	Give short-acting nitrates day 2	36	54
Patients with chest pain day 1 and 2 and no evidence of hypotension or congestive heart failure on day 1 or 2 and no IV unloading agents on day 2	Give long acting nitrates, oral or IV beta blockers, or calcium channel blockers on day 2	19	73

Table C.13 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients with chest pain day 1 and 2 and evidence of hypotension or congestive heart failure on day 1 or 2 and no IV unloading agents on day 2	Give long acting nitrates or calcium channel blockers on day 2	15	71
All Patients	On day 3 of the hospitalization, the physician should document each of the following in the medical record:		
	Chest pain (presence or absence)	100	65
	Lung examination	100	67
All Patients	On day 3 of the hospitalization, the nurse should document each of the following in the medical record:		
	Chest pain (presence or absence)	100	92
	Premature ventricular contractions (PVCs) assessed	100	70
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order chest X-ray on day 3	2	56
Patients with chest pain or somewhat, moderately, or very sick (i.e., ASSC >= 3) on day 3	Order electrocardiogram on day 3	45	79
Patients somewhat sick (i.e., ASSC = 3-4) on day 3	Order at least 1 of the following laboratory studies on day 3: BUN, creatinine, sodium, potassium	17	53
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order at least 2 of the following laboratory studies on day 3: BUN, creatinine, sodium, potassium	12	62
Patients with chest pain day 3	Order cardiac enzyme study day 3 (e.g., creatine phosphokinase (CPK) or lactate dehydrogenase (LDH) isoenzymes or total CPK)	19	35
Patients moderately or very sick (i.e., ASSC >=5) day 3	Obtain arterial blood gas day 3	--	--
Patients very sick (i.e., ASSC >= 7) day 3	Use intensive care unit (ICU) day 3. Telemetry is not sufficient but is preferable to no cardiac monitoring	5	94 ICU 3 Telemetry

Table C.13 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients moderately sick (i.e., ASSC = 5-6) day 3	Use ICU day 3. Telemetry is not sufficient but is preferable to no cardiac monitoring	7	90 ICU 9 Telemetry
Patients somewhat sick (i.e., ASSC =3-4) day 3	Use ICU day 3. Telemetry is not sufficient but is preferable to no cardiac monitoring	17	84 ICU 13 Telemetry
Patients at least somewhat sick (i.e., ASSC >=3) on day 2 with or without shock and congestive heart failure but not very sick (i.e., ASSC <=2) on day 3 with or without evidence of AMI	Use ICU day 3. Telemetry is not sufficient but is preferable to no cardiac monitoring	19	85 ICU 11 Telemetry
Patients not very sick (i.e,. ASSC <=2) on day 2 and with AMI and not very sick (i.e., ASSC <= 2) day 3	Use ICU day 3 or use telemetry day 3. ICU is preferable.	41	75 ICU 20 Telemetry
Patients not very sick (i.e., ASSC <= 2) on day 2 and with no evidence of AMI and not very sick (i.e., ASSC <= 2) on day 3	Monitoring day 3 in ICU or telemetry is not necessary.	10	61 ICU 27 Telemetry
Patients with hypotension and moderately or very sick (i.e., ASSC >= 5) day 3	Use pressors or IV unloading agents day 3	9	57
Patients with ventricular Tachycardia (VTach) day 1 or 2 or PVCs day 3	Give antiarrhythmics or oral or IVs blockers day 3	10	65
Patients with hypertension (diastolic BP >= 105) persisting for day 2 and 3	Give IV unloading agents, long acting nitrates, oral or IV B blockers, or calcium channel blockers day 3	1	82
Patients with chest pain and no IV unloading agents on day 3	Give short acting nitrates day 3	26	54

Table C.13 (continued)

If	Then	Patients to Whom Criteria Are Applicable (%)	Patients Meeting Process Criteria (%)
Patients with chest pain day 2 and 3 and no evidence of hypotension or congestive heart failure on day 1 or 2 and no IV unloading agents on day 3	Give long acting nitrates, oral or IV B blockers, or calcium channel blockers on day 3	10	80
Patients with chest pain day 2 and 3 and evidence of hypotension or congestive heart failure on day 1 or 2 and no IV unloading agents on day 3	Give long acting nitrates or calcium channel blockers on day 3	8	78

NOTE: ASSC (Any Symptom or Sign Complex) for patients with acute myocardial infarction is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; chest pain, 1 point; confusion, 2 points; heart rate >= 130, 2 points; respiratory rate >= 30 per minutes, 2 points; diastolic blood pressure >= 105 mm Hg 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table C.14

PROCESS CRITERIA FOR PNEUMONIA

If	Then	Patients to Whom Criteria Are Applicable	Patients Meeting Process Criteria
All patients hospitalized for PNE	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:		
	Sputum or cough (presence or absence)	100	78
	Previous pulmonary disease (presence or absence)	100	60
	Medication use immediately before admission	100	73
	Alcohol use (or non-use)	100	42
	Tobacco use (or non-use)	100	50
	Temperature	100	78
	Jugular veins examined	100	45
	Heart murmurs examined	100	76
	Lower extremity examined for edema	100	72
	Mental status assessed	100	63
	Lung examination day 1	100	98
	Lung examination day 2	100	64
	Shortness of breath (presence or absence) day 1	100	70
	Shortness of breath (presence or absence) day 2	100	28
All patients hospitalized for PNE	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:		
	Shortness of breath (presence or absence) day 1	100	73
	Shortness of breath (presence or absence) day 2	100	78
	Blood pressure assessment at least 3 times day 2	100	74
	Urinary continence (presence or absence)	100	71
	Ambulatory status	100	73
	Preadmission residence	100	97
Patients moderately or very sick (i.e., ASSC >= 5) day 1 or 2	Within the initial two days of hospitalization, order:		
	Chest X-ray	31	99
	Electrocardiogram	31	76
All patients hospitalized for PNE	Within the initial two days of hospitalization, order each of the following laboratory studies:		
	BUN	100	87
	Creatinine	100	72
	Venous bicarbonate	100	80
	Sodium	100	90
	Potassium	100	90
	White blood count	100	98
	Hematocrit or hemoglobin	100	98
	White blood cell count differential	100	95

Table C.14 (continued)

If	Then	Patients to Whom Criteria Are Applicable	Patients Meeting Process Criteria
Patients moderately or very sick (i.e., ASSC >= 5) day 1 or 2	Order cardiac enzyme study day 1 or 2 (e.g., CPK)	31	34
Patients moderately or very sick (i.e., ASSC >= 5) day 1 or 2	Obtain arterial blood gas day 1 or 2	30	75
Patients somewhat sick (i.e., ASSC = 3-4) day 1	Use the intensive care unit day 1 or Use telemetry day 1	29	8 ICU 8 Telemetry
Patients somewhat sick (i.e., ASSC = 3-4) day 2	Use the intensive care unit day 2 or Use telemetry day 2	17	18 ICU 8 Telemetry
Patients moderately sick (i.e., ASSC 5-6) day 1	Use the intensive care unit day 1 or Use telemetry day 1	18	19 ICU 10 Telemetry
Patients moderately sick (i.e., ASSC 5-6) day 2	Use the intensive care unit day 2 or Use telemetry day 2	8	33 ICU 8 Telemetry
Patients very sick (i.e., ASSC >= 7) day 1	Use the intensive care unit day 1 Telemetry is not sufficient but is preferable to no cardiac monitoring day 1	10	46 ICU 6 Telemetry
Patients very sick (i.e., ASSC >= 7) day 2	Use the intensive care unit day 2 Telemetry is not sufficient but is preferable to no cardiac monitoring day 2	4	53 ICU 14 Telemetry
Patients are hypoxic (i.e., p02 < 60) on day 1	Use supplemental oxygen therapy or intubate day 1	27	87
Patients are hypoxic (i.e., p02 < 60) on day 2	Use supplemental oxygen therapy or intubate day 2	8	93
Patients are moderately or very sick (i.e., ASSC >= 5) day 1 and day 2 and arterial blood gases were not evaluated on either day	Use supplemental oxygen therapy or intubate day 1 or 2	1	73

Table C.14 (continued)

If	Then	Patients to Whom Criteria Are Applicable	Patients Meeting Process Criteria
All non-immunocompromised with PNE	Use antibiotics within the first 4 hours	90	31
All immunocompromised patients hospitalized with PNE	Use antibiotics within the first 2 hours	10	4
Patients with fever (T > 101) on day 1 or 2	Order blood cultures day 1 or 2	42	62
Patients with fever (T > 101) on day 1 or 2	Order urine culture or urinalyses day 1 or 2	42	86
Patients with sputum for culture day 1 or 2	Document sputum gram stain quality day 1 or 2	53	64
All patients hospitalized for PNE	On hospital day 3, the physician should document each of the following in the medical record:		
	Shortness of breath (presence or absence)	100	24
	Lung examination	100	62
All patients hospitalized for PNE	On hospital day 3, the nurse should document in the medical record:		
	Shortness of breath (presence or absence)	100	78
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order a chest X-ray or an electrocardiogram on day 3	9	54
Patients somewhat sick (i.e., ASSC 3-4) on day 3	Order at least 1 of 4 venous blood studies on day 3 (e.g., creatinine, BUN, sodium, potassium)	13	42
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order at least 2 of 4 venous blood tests (e.g., creatinine, BUN, sodium, potassium)	9	55
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Order a cardiac enzyme study (e.g., CPK) day 3	9	16
Patients moderately or very sick (i.e., ASSC >= 5) on day 3	Obtain an arterial blood gas day 3	9	54

Table C.14 (continued)

If	Then	Patients to Whom Criteria Are Applicable	Patients Meeting Process Criteria
Patients somewhat sick (i.e., ASSC 3-4) day 3	Use the intensive care unit day 3 or Use telemetry day 3	13	19 ICU 9 Telemetry
Patients moderately sick (i.e., ASSC 5-6) on day 3	Use the intensive care unit day 3 or Use telemetry day 3	6	33 ICU 9 Telemetry
Patients very sick (i.e., ASSC >= 7) on day 3	Use the intensive care unit day 3 Telemetry is not sufficient but is preferable to no cardiac monitoring day 3	3	65 ICU 12 Telemetry
Patients are hypoxic (i.e., p02 < 60) on day 3	Use supplemental oxygen therapy or intubate day 3	5	92

NOTE: ASSC (Any Symptom or Sign Complex) for pneumonia patients is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; chest pain, 1 point; confusion, 2 points; heart rate >= 130 beats per minute, 2 points; respiratory rate >= 30 per minute, 2 points; diastolic blood pressure >= 105 mm Hg 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table C.15

PROCESS CRITERIA FOR CEREBROVASCULAR ACCIDENT (CVA)

If	Then	Patients to Whom Criteria Are Applicable %	Patients Meeting Process Criteria %
All patients	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:		
	Previous cardiac history or hypertension	100	82
	Time of onset of neurologic symptoms	100	92
	Prior CVA/TIA	100	51
	Medication use immediately before admission	100	78
	Pupils assessed	100	81
	Gag reflex assessed	100	36
	Carotid bruits assessed	100	67
	Heart sounds assessed	100	60
	Muscle tone/strength assessed	100	84
	Limb reflexes assessed	100	68
	Mental status assessed	100	83
	Neurologic deficits (presence or absence) day 1	100	99
	Neurologic deficits (presence or absence) day 2	100	80
	Visit to patient day 1	100	100
	Visit to patient day 2	100	94
All patients	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:		
	Nutritional intake assessed day 1	100	62
	Nutritional intake assessed day 2	100	89
	Pupils assessed day 1	100	53
	Pupils assessed day 2	100	48
	Blood pressure measured at least 3 times on day 2	100	83
All patients	Within the initial two days of hospitalization, either the physician or the nurse should document each of the following in the medical record:		
	Urinary continence (presence or absence)	100	64
	Ambulatory status	100	77
	Preadmission residence	100	97
All patients	Within the initial two days of hospitalization, order each of the following:		
	Chest X-ray	100	80
	Electrocardiogram	100	84

Table C.15 (continued)

If	Then	Patients to Whom Criteria Are Applicable %	Patients Meeting Process Criteria %
All patients	Within the initial two days of hospitalization, order each of the following laboratory studies:		
	Blood urea nitrogen (BUN)	100	88
	Creatinine	100	71
	Venous bicarbonate	100	82
	Sodium	100	91
	Potassium	100	91
	White blood count	100	95
	Hematocrit or hemoglobin	100	94
Patients moderately, or very sick (i.e., ASSC >=2) day 1 or 2	Obtain arterial blood gas day 1 or 2	27	52
Patients moderately sick (i.e., ASSC = 2-3) day 1	Use ICU day 1	14	33
Patients very sick (i.e., ASSC >=4) day 1	Use ICU day 1	6	56
Patients moderately sick (i.e., ASSC = 2-3) day 2	Use ICU day 2	12	37
Patients very sick (i.e., ASSC >= 4) day 2	Use ICU day 2	4	51
Posturing, no response to pain, or coma	Do CT scan, carotid angiography, brain scan, encephalogram, or lumbar puncture day 1 or 2	26	47
All patients	On day 3 of the hospitalization, the physician should document each of the following in the medical record:		
	Neurologic deficits (presence or absence)	100	73
	Lung examination	100	35
	Visit to patient	100	94
All patients	On day 3 of the hospitalization, the nurse should document each of the following in the medical record:		
	Nutritional intake assessed	100	89
	Pupils assessed	100	40
Patients moderately sick (i.e., ASSC = 2-3) on day 3	Order at least 3 of the following laboratory studies on day 3: BUN, creatinine, sodium, potassium, white blood cell count, hematocrit or hemoglobin, venous bicarbonate	10	43

Table C.15 (continued)

If	Then	Patients to Whom Criteria Are Applicable %	Patients Meeting Process Criteria %
Patients very sick (i.e., ASSC >= 4) on day 3	Order at least 4 of the following laboratory studies on day 3: BUN, creatinine, sodium, potassium, white blood cell count, hematocrit or hemoglobin, venous bicarbonate	3	5
Patients moderately sick (i.e., ASSC =2-3) day 3	Use intensive care unit (ICU) day 3	10	35
Patients very sick (i.e., ASSC >= 4) day 3	Use intensive care unit (ICU) day 3	3	57

NOTE: ASSC (Any Symptom or Sign Complex) for patients with cerebrovascular accident is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: shortness of breath, 1 point; heart rate >= 130 beats per minute, 2 points; respiratory rate >= 30 per minute, 2 points; diastolic blood pressure >= 105 mm Hg 1 point; systolic blood pressure < 90 mm Hg, 3 points.

Table C.16

PROCESS CRITERIA FOR HIP FRACTURE

If	Then	Patients to whom Criteria Are Applicable	Patients Meeting Process Criteria
All patients	Within the initial two days of hospitalization, the physician should document each of the following in the medical record:		
	Past surgical history	100	76
	Medication use immediately before admission	100	83
	Prior living arrangements	100	71
	Alcohol use (or non-use) or smoking habits	100	48
	Circumstances of hip injury	100	98
	Neck examined	100	90
	Heart examined	100	98
	Lungs examined	100	98
	Lower extremity examined for pulses	100	64
	Mental status assessed	100	69
All patients	Within the initial two days of hospitalization, the nurse should document each of the following in the medical record:		
	Urinary continence (presence or absence)	100	66
	Ambulatory status	100	88
	Preadmission residence	100	98
All patients	Within the initial two days of hospitalization, order:		
	Chest X-ray	100	93
	Electrocardiogram	100	92
All patients	Within the initial two days of hospitalization, order each of the following laboratory studies:		
	BUN	100	87
	Creatinine	100	66
	Sodium	100	90
	Potassium	100	91
	White blood count	100	96
	Hematocrit or hemoglobin	100	97

NOTE: ASSC (Any Symptom or Sign Complex) for hip fracture patients is defined by a weighted sum of scores assigned for the presence of each of the following on any given days. Weights are assigned as follows: heart rate >= 130 beats per minute, 2 points; respiratory rate >= 30 per minute, 2 points; diastolic blood pressure >= 105 mm Hg 1 point; systolic blood pressure < 90 mm Hg, 3 points.

PERFORMANCE ON PROCESS CRITERIA FOR PRE- AND POST-PPS SAMPLE COMBINED

Tables C.17 through C.31 show the fraction of patients who meet specific process criteria across each of the five study diseases for the pre- and post-PPS sample combined.

PERFORMANCE ON PROCESS CRITERIA FOR PRE- VERSUS POST-PPS SAMPLE

Tables C.32 through C.49 show the fraction of patients who meet specific process criteria across each of the five study diseases for the pre-PPS versus the post-PPS sample.

DEVELOPING PROCESS SCALES

In using the medical record as a data base for measuring quality, we cannot measure all aspects of quality. Instead, we select a group of processes that in combination are a proxy for actual processes delivered to patients. When process measures are aggregated from similar measurements of the same concept, it is appropriate to develop a scale. This subsection introduces the subject of process scale development. In all instances, the process measures described here refer to those listed above.

For this study, we have several measures that, when aggregated, measure similar concepts. Examples include initial MD cognitive assessment, initial RN assessment, and initial laboratory assessment. With the process criteria for MD cognitive assessment, we are attempting to study a sample of cases to determine how well the physician evaluates the patient's past history (e.g., prior surgeries), present illness (e.g., sputum or cough), and physical examination (e.g., pupils examined). We employ these items as a proxy for how well the physician uses the history and physical to collect data about the patient. Our disease-specific panels believed that each of these items should be documented in the medical record of hospitalized patients. The idea is not that a physician must document each of these factors in the medical record. Rather, the idea is that the more thoroughly the physician documents these disease-specific items during the initial hospital stay, the more likely the physician is to be competent as a collector of the patient's data.

With the process criteria for initial RN assessment, we are attempting to study a sample of nursing activities. How well does the nurse perform cognitive services (e.g., assess shortness of breath, ambulatory status)? How adequately does the nurse perform technical nursing activities (e.g., blood pressure measurement, weighing patients with congestive heart failure)? Again the goal of the process items is to sample nursing activities that aggregately are a measure of nursing care.

For initial laboratory process criteria, specific laboratory studies are identified as important for study at admission for hospitalized patients. Again, the idea is not that a physician remiss in ordering a specified laboratory study is necessarily a poor physician. Rather the idea is that the laboratory studies we assess are likely to be a proxy for the physician's initial use of laboratory tests.

For each of these three process concepts, the criteria belong together on a scale if physicians and nurses who perform well on one of the criteria are likely to do well on all, and if a negligent physician or nurse is likely to perform poorly on all measures for that scale.

Table C.17

PERFORMANCE ON INITIAL COGNITIVE MD PROCESS CRITERIA BY DISEASE
(Pre- and post-PPS combined)

Process Criteria (1)	Assigned Points	Applicable Points	% of Patients Meeting Process Criteria				
Within the first 2 hospital days, physicians should document each of the following:			CHF (n=2824)	AMI (n=2853)	PNE (n=2749)	CVA (n=2824)	HIP (n=2762)
Previous cardiac history noted	1	1	--	88	--	--	--
Prior cardiac history or hypertension noted	1	1	--	--	--	82	--
Previous pulmonary disease noted	1	1	--	--	60	--	--
Past surgeries noted	1	1	64	--	--	--	76
Time of onset of symptoms noted	1	1	--	96	--	92	--
Sputum or cough noted	1	1	--	--	78	--	--
Circumstances of hip injury noted	1	1	--	--	--	--	98
Medications noted	1	1	81	84	73	78	83
Allergies noted	1	1	55	59	--	--	--
Social or family history noted	1	1	--	64	--	--	--
Prior living arrangements noted	1	1	--	--	--	--	71
Alcoholism or smoking habits noted	1	1	--	63	--	--	48
Alcohol use noted	1	1	45	--	42	--	--
Tobacco use noted	1	1	--	--	50	--	--
Prior CVA noted	1	1	--	--	--	51	--
Temperature noted	1	1	--	--	78	--	--
Mental status noted	1	1	--	--	63	83	69
Pupils noted	1	1	--	--	--	81	--
Jugular veins noted	1	1	67	65	45	--	--
Gag reflex noted	1	1	--	--	--	36	--
Carotid bruits noted	1	1	--	--	--	67	--
Neck noted	1	1	--	--	--	--	90
Heart noted	1	1	--	--	--	--	98
Heart sounds noted	1	1	70	79	--	60	--
Heart murmurs noted	1	1	79	84	76	--	--
Lungs noted	1	1	--	--	--	--	98
Abdomen noted	1	1	98	97	--	--	--
Muscle tone or strength noted	1	1	--	--	--	84	--
Pedal or leg pulse noted	1	1	--	--	--	--	64
Lower extremity edema noted	1	1	91	80	72	--	--
Limb reflexes noted	1	1	--	--	--	68	--
SOB assessed.D1H	1	1	--	--	70	--	--
SOB assessed.D2H	1	1	--	--	28	--	--
Lung exam done.D1H	1	1	98	97	98	--	--
Lung exam done.D2H	1	1	64	67	64	--	--
Chest pain noted.D1H	1	1	--	94	--	--	--
Chest pain noted.D2H	1	1	--	67	--	--	--
Deficits noted.D1H	1	1	--	--	--	99	--
Deficits noted.D2H	1	1	--	--	--	80	--
MD note.D1H	1	1	--	--	--	100	--
MD note.D2H	1	1	--	--	--	94	--
Total Number of Process Criteria			11	15	14	15	10

(1) All patients are applicable.

Table C.18

PERFORMANCE ON INITIAL RN PROCESS CRITERIA BY DISEASE
(Pre- and post-PPS combined)

Process Criteria (1)	Assigned Points	Applicable Points	% of Patients Meeting Process Criteria				
Within the first 2 hospital days, nurses should document each of the following:			CHF (n=2824)	AMI (n=2853)	PNE (n=2749)	CVA (n=2824)	HIP (n=2762)
SOB assessed.D1H	1	1	90	--	73	--	--
SOB assessed.D2H	1	1	90	--	78	--	--
Chest pain assessed.D1H	1	1	--	92	--	--	--
Chest pain assessed.D2H	1	1	--	92	--	--	--
PVCs assessed.D1H	1	1	--	65	--	--	--
PVCs assessed.D2H	1	1	--	73	--	--	--
Pupils assessed.D1H	1	1	--	--	--	53	--
Pupils assessed.D2H	1	1	--	--	--	48	--
Nutritional intake noted.D1H	1	1	--	--	--	62	--
Nutritional intake noted.D2H	1	1	--	--	--	89	--
Weight taken.D1H or D2H (2)	1	1	--	62	--	--	--
Blood pressure taken >= 3 times.D2H	1	1	81	--	74	83	--
Monitor strips >= 3.D1H	1	1	--	81	--	--	--
Urinary continence noted	1	1	69	--	71	64	66
Ambulatory status noted	1	1	75	--	73	77	88
Preadmission residence noted	1	1	94	93	97	97	98
Total # of process criteria			6	7	6	8	3

(1) All patients are applicable for each listed process criteria within the relevant disease column.
(2) Applicable patients for AMI are those without shock or congestive heart failure on day 1 and 2 (i.e., 71 percent of patients).

Table C.19

PERFORMANCE ON INITIAL CHEST X-RAY AND ELECTROCARDIOGRAM PROCESS BY DISEASE

(Pre- and post-PPS combined)

Disease	Patient Subset (1)	Process Criteria	Assigned Points	Applicable Points	Applicable Patients (2)	Patients Meeting Criteria (3)
CHF	All patients day 1 or 2	Chest X-ray	2	2	100	95
	All patients day 1 or 2	EKG	2	2	100	89
AMI	All patients day 1 or 2	Chest X-ray	3	3	100	92
	All patients day 1	EKG	3	3	100	95
	All patients day 2	EKG	3	3	100	90
PNE (4)	If moderately or very sick (i.e., ASSC >= 5) day 1 or 2	Chest X-ray	2	2	31	99
	If moderately or very sick (i.e., ASSC >= 5) day 1 or 2	EKG	2	2	31	76
CVA	All patients day 1 or 2	Chest X-ray	2	2	100	80
	All patients day 1 or 2	EKG	2	2	100	84
HIP	All patients day 1 or 2	Chest X-ray	2	2	100	93
	All patients day 1 or 2	EKG	2	2	100	92

(1) Defines patients to whom process criteria are applicable.

(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of applicable patients who meet the process criteria.

(4) Since pneumonia patients could have had a chest X-ray and EKG in the week before admission these were required of only the sicker patients on day 1 or 2.

Table C.20

PERFORMANCE ON INITIAL LABORATORY ORDERING CRITERIA FOR BLOOD CHEMISTRY AND HEMATOLOGY STUDIES

(Pre- and post-PPS combined)

Process Criteria (1)	Assigned Points	Applicable Points	Applicable Patients	% of Patients Meeting Criteria				
				CHF	AMI	PNE	CVA	HIP
Within the first 2 hospital days, physicians should order each of the following:								
Venous bicarbonate	1	1	100	83	84	80	82	--
Creatinine	1	1	100	75	72	72	71	66
BUN	1	1	100	90	89	87	88	87
Sodium	1	1	100	95	94	90	91	90
Potassium	1	1	100	95	94	90	91	91
White blood count	1	1	100	93	95	98	95	96
Hematocrit	1	1	100	93	96	98	94	97
White blood count differential	1	1	100	--	--	95	--	--

(1) All patients are applicable.

Table C.21

PERFORMANCE ON INITIAL LABORATORY ORDERING CRITERIA FOR CPK AND ARTERIAL BLOOD GAS BY DISEASE

Disease	Patient Subset (1)	Process Criteria	Assigned Points	Applicable Points	Applicable Patients (2)	Patients Meeting Criteria (3)
CHF	Moderately or very sick (i.e., ASSC >= 5) day 1 or 2	CPK day 1 or 2	2	2	26	67
	Moderately or very sick (i.e., ASSC >= 5) day 1 or 2	ABG day 1 or 2	2	2	26	75
AMI	All patients day 1	CPK or LDH isoenzymes day 1	4	4	100	44
		Total CPK only day 1	3	4	100	45
	All patients day 2	CPK or LDH isoenzymes day 2	3	3	100	54
		Total CPK only day 2	2	3	100	35
	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	ABG day 1 or 2	2	2	34	71
PNE	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	CPK day 1 or 2	2	2	31	34
	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	ABG day 1 or 2	2	2	30	75
CVA (4)	Moderately or very sick (i.e., ASSC >= 2) Day 1 or 2	ABG day 1 or 2	2	2	27	52

(1) Defines patients to whom process criteria are applicable.

(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of applicable patients who meet the process criteria.

(4) ASSC for CVA is based on 5 components rather than the 7 components used for CHF, AMI, and PNE.

Table C.22

PERFORMANCE ON DAY 1 USE OF ICU AND TELEMETRY PROCESS CRITERIA (4)
(Pre- and post-PPS combined)

Patient Subsets (1)	Process Criteria	Assigned Points	Applicable Points	CHF		AMI		PNE		CVA	
				Applicable Patients (2)	Patients Meeting Criteria(3)	Applicable Patients (2)	Patients Meeting Criteria (3)	Applicable Patients (2)	Patients Meeting Criteria (3)	Applicable Patients (2)	Patients Meeting Criteria (3)
Somewhat sick (i.e., ASSC = 3-4)	CCU	2	2	--	--	--	--	29	8	--	--
	Telemetry	1	2	--	--	--	--	29	8	--	--
Moderately sick (i.e., ASSC = 5-6)	CCU	3	3	16	44	--	--	18	19	--	--
	Telemetry	2	3	16	16	--	--	18	10	--	--
Very sick (i.e., ASSC >= 7)	CCU	7	7	6	67	--	--	10	46	--	--
	Telemetry	3	7	6	15	--	--	10	6	--	--
Cardiogenic shock with end organ damage arrhythmias, and very sick (i.e., ASSC >= 7)	CCU	7	7	--	--	6	92	--	--	--	--
	Telemetry	1	7	--	--	6	4	--	--	--	--
Shock or very sick (i.e., ASSC >= 7)	CCU	7	7	--	--	16	89	--	--	--	--
	Telemetry	1	7	--	--	16	7	--	--	--	--
Moderately sick (i.e., ASSC = 5-6)	CCU	6	6	--	--	8	82	--	--	--	--
	Telemetry	2	6	--	--	8	12	--	--	--	--
Congestive heart failure and somewhat sick (i.e., ASSC = 3-4)	CCU	6	6	--	--	8	80	--	--	--	--
	Telemetry	2	6	--	--	8	12	--	--	--	--
Congestive heart failure and not very sick (i.e., ASSC <= 2)	CCU	5	5	--	--	11	76	--	--	--	--
	Telemetry	2	5	--	--	11	17	--	--	--	--
Somewhat sick (i.e., ASSC = 3-4)	CCU	5	5	--	--	14	76	--	--	--	--
	Telemetry	2	5	--	--	14	17	--	--	--	--
Not very sick but some symptom or sign (i.e., ASSC = 2)	CCU	4	4	--	--	19	75	--	--	--	--
	Telemetry	2	4	--	--	19	18	--	--	--	--
AMI with no more than one symptom or sign	CCU	4	4	--	--	15	74	--	--	--	--
	Telemetry	2	4	--	--	15	20	--	--	--	--
No evidence of AMI	CCU	4	4	--	--	3	62	--	--	--	--
	Telemetry	3	4	--	--	3	25	--	--	--	--
Moderately sick (i.e., ASSC = 2-3)	CCU	3	3	--	--	--	--	--	--	14	33
	Telemetry	--	--	--	--	--	--	--	--	--	--
Very sick (i.e., ASSC >= 4)	CCU	7	7							6	56
	Telemetry	--	--	--	--	--	--	--	--	--	--

(1) Defines patients to whom process criteria are applicable.
(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of applicable patients who meet the process criteria.
(4) No ICU/telemetry criteria for hip fracture patients.

Table C.23

PERFORMANCE ON DAY 2 USE OF ICU AND TELEMETRY PROCESS CRITERIA (4)
Pre- and Post-PPS Combined

				CHF % of Patients		AMI % of Patients		PNE % of Patients		CVA % of Patients	
Patient Subsets(1)	Process Criteria	Assigned Points	Applicable Points	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
Somewhat sick (i.e., ASSC = 3-4)	CCU	2	2	-	-	-	-	17	18	-	-
	Telemetry	1	2	-	-	-	-	17	8	-	-
Moderately sick (i.e., ASSC = 5-6)	CCU	3	3	7	45	-	-	8	33	-	-
	Telemetry	2	3	7	23	-	-	8	8	-	-
Very Sick (i.e., ASSC >= 7)	CCU	7	7	2	65	-	-	4	53	-	-
	Telemetry	3	7	2	17	-	-	4	14	-	-
Cardiogenic Shock with End Organ Damage, Arrhythmias, AND Very sick (i.e., ASSC >= 7)	CCU	7	7	-	-	4	96	-	-	-	-
	Telemetry	1	7	-	-	4	4	-	-	-	-
Shock OR very sick (i.e., ASSC <= 7)	CCU	7	7	-	-	13	89	-	-	-	-
	Telemetry	1	7	-	-	13	8	-	-	-	-
Moderately Sick (i.e., ASSC = 5-6)	CCU	6	6	-	-	4	87	-	-	-	-
	Telemetry	2	6	-	-	4	10	-	-	-	-
Congestive Heart Failure AND Somewhat Sick (i.e., ASSC = 3-4)	CCU	6	6	-	-	3	88	-	-	-	-
	Telemetry	2	6	-	-	3	7	-	-	-	-
Congestive Heart Failure AND Not very sick (i.e., ASSC <= 2)	CCU	5	5	-	-	7	90	-	-	-	-
	Telemetry	2	5	-	-	7	8	-	-	-	-
Somewhat sick (i.e., ASSC =3-4)	CCU	5	5	-	-	10	84	-	-	-	-
	Telemetry	2	5	-	-	10	11	-	-	-	-
Not very sick but some symptom or sign (i.e., ASSC = 2)	CCU	4	4	-	-	10	81	-	-	-	-
	Telemetry	2	4	-	-	10	15	-	-	-	-
AMI with no more than one symptom or sign other than chest pain	CCU	4	4	-	-	39	77	-	-	-	-
	Telemetry	2	4	-	-	39	17	-	-	-	-
No Evidence of AMI	CCU	4	4	-	-	10	65	-	-	-	-
	Telemetry	3	4	-	-	10	25	-	-	-	-
Moderately sick (i.e., ASSC 2-3)	CCU	3	3	-	-	-	-	-	-	12	37
	Telemetry	-	-	-	-	-	-	-	-	-	-
Very sick (i.e., ASSC >= 4)	CCU	7	7	-	-	-	-	-	-	4	51
	Telemetry	-	-	-	-	-	-	-	-	-	-

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.
(4) No ICU/Telemetry criteria for hip fracture patients.

Table C.24

PERFORMANCE ON INITIAL PROCESS FOR USE OF MEDICATIONS AND SPECIAL TESTS OR PROCEDURES
Pre- and Post-PPS Combined

				CHF % of Patients		AMI % of Patients		PNE % of Patients		CVA % of Patients	
Patient Subsets (1)	Process Criteria	Assigned Points	Applicable Points	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
pO2 < 60 Day 1	Use O2 or intubation Day 1	3	3	18	90	-	-	27	87	-	-
pO2 < 60 Day 2	Use O2 or intubation Day 2	3	3	4	91	-	-	8	93	-	-
No ABCs and Moderately or Very Sick (i.e., ASSC >= 5) Day 1 and 2	Use O2 or intubation Day 1 or 2	3	3	1	94	-	-	1	73	-	-
SBP >= 90 Day 1 and Day2	Use digitalis or diuretics Day 1 or 2	2	2	92	95	-	-	-	-	-	-
Cardiogenic shock with End Organ Damage, Arrhythmics, AND Very sick (i.e., ASSC >= 7) Day 1 or 2	Swan Ganz Catheter Day 1 or 2	4	4	-	-	8	34	-	-	-	-
Cardiogenic shock with End Organ Damage, Arrhythmics, AND Very sick (i.e., ASSC >= 7) Day 1	Pressors or IV unloading agents Day 1	5	5	-	-	6	74	-	-	-	-
Cardiogenic shock with End Organ Damage, Arrhythmics, AND Very sick (i.e., ASSC >= 7) Day 2	Pressors or IV unloading agents Day 2	5	5	-	-	4	75	-	-	-	-
Ventricular tachycardia Day 1	Antiarrhythmics	7	7	-	-	1	94	-	-	-	-
PVCs Day 1	Antiarrhythmics Day 1	4	4	-	-	23	69	-	-	-	-
Ventricular tachycardia	Antiarrhythmics Day 2	7	7	-	-	1	70	-	-	-	-
PVCs Day 2	Antiarrhythmics Day 2	4	4	-	-	17	63	-	-	-	-
Third degree heart block Day 1 or 2 AND Anterior AMI	Pacemaker Day 1 or 2	7	7	-	-	1	77	-	-	-	-
Third degree heart block Day 1 or 2 but not Anterior AMI	Pacemaker Day 1 or 2	4	4	-	-	3	62	-	-	-	-
Patient given Stroptokinase	Note on Bleeding History	1	1	-	-	2	13	-	-	-	-
Patient given streptokinase	Stroptokinase given within 6 hours of time symptoms 1st noted	5	5	-	-	2	69	-	-	-	-
Congestive heart failure but no shock Day 1	Loop diuretics Day 1	5	5	-	-	19	53	-	-	-	-
Congestive heart failure but no shock Day 2	Loop diuretics Day 2	5	5	-	-	9	67	-	-	-	-
Hypertension Day 1 and 2	IV unloading agents, long-acting nitrates, oral or IV B blockers, OR Ca channel blockers Day 2	5	5	-	-	3	67	-	-	-	-
Chest pain noted by MD or RN Day 2 and no IV unloading agents Day 2	Short-acting nitrates Day 2	1	1	-	-	36	54	-	-	-	-
Chest pain noted by MD or RN Day 1 and 2 AND no evidence of shock or congestive heart failure Day 1 and 2 AND no IV unloading agents Day 2	Long-acting nitrates, oral or IV B blockers, or Ca channel blockers Day 2	3	3	-	-	19	73	-	-	-	-
Chest pain noted by MD or RN Day 1 and 2 AND evidence of shock or congestive heart failure Day 1 or 2 AND no IV unloading agents Day 2	Long-acting nitrates or Ca channel blockers Day 2	3	3	-	-	15	71	-	-	-	-
T > 38.3 C Day 1 or 2	Blood culture Day 1 or 2	1	1	-	-	-	-	42	62	-	-
T > 38.3 C Day 1 or 2	Urine culture or urinalysis Day 1 or 2	1	1	-	-	-	-	42	86	-	-
Sputum sent for culture	Sputum gram stain quality noted	1	1	-	-	-	-	53	64	-	-
Not immunocompromised	Begin antibiotics in a timely manner			-	-	-	-	90			
	< 120 min	5	5	-	-	-	-	-	11	-	-
	120-239 min	5	5	-	-	-	-	-	20	-	-
	240-359 min	4	5	-	-	-	-	-	18	-	-
	360-479 min	3	5	-	-	-	-	-	14	-	-
	480-719 min	2	5	-	-	-	-	-	11	-	-
	720-1439 min	1	5	-	-	-	-	-	10	-	-
	1440-2880 min	1	5	-	-	-	-	-	5	-	-
	> 2880 min or No Antibiotic	0	5	-	-	-	-	-	11	-	-
Immunocompromised	Begin antibiotics in a timely manner			-	-	-	-	10			
	< 120 min	7	7	-	-	-	-	-	4	-	-
	120-239 min	6	7	-	-	-	-	-	23	-	-
	240-359 min	3	7	-	-	-	-	-	20	-	-
	360-479 min	2	7	-	-	-	-	-	14	-	-
	480-719 min	2	7	-	-	-	-	-	10	-	-
	720-1439 min	1	7	-	-	-	-	-	10	-	-
	1440-2880 min	1	7	-	-	-	-	-	4	-	-
	> 2880 min or No Antibiotic	0	7	-	-	-	-	-	15	-	-
Posturing, no response to pain	CT, carotid angiography/brain scan, EEC, or LP	3	3	-	-	-	-	-	-	26	47

(1) Defines patients to whom process criteria are applicable.
(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of applicable patients who meet the process criteria.

Table C.25

PERFORMANCE ON DAY 3 PROCESS CRITERIA (1)
(Pre- and post-PPS combined)

Process Scale and Patient Subset (2)	Process Criteria	Assigned Points	Applicable Points	CHF		AMI		PNE		CVA	
				Applicable Patients (3)	Patients Meeting Criteria (4)	Applicable Patients (3)	Patients Meeting Criteria (4)	Applicable Patients (2)	Patients Meeting Criteria (3)	Applicable Patients (2)	Patients Meeting Criteria(3)
Physician assessment											
All patients	SOB assessed	1	1	100	50	--	--	100	24	--	--
	Lung assessed	1	1	100	64	100	67	100	62	100	35
	Chest pain assessed	1	1	--	--	100	65	--	--	--	--
	MO note	1	1	--	--	--	--	--	--	100	94
	Note on deficit	1	1	--	--	--	--	--	--	100	73
Nurse assessment											
All patients	SO8 assessed	1	1	100	88	--	--	100	78	--	--
	Chest pain assessed	1	1	--	--	100	92	--	--	--	--
	PVCs assessed	1	1	--	--	100	70	--	--	--	--
	Nutrition assessed	1	1	--	--	--	--	--	--	100	89
	Pupils assessed	1	1	--	--	--	--	--	--	100	40
Chest X-ray & Electrocardiogram											
Moderately or very sick (i.e., ASSC >= 5)	Chest X-ray only	2	2	7	35	12	56	--	--	--	--
	EKG only	2	2	7	38	--	--	--	--	--	--
	Either chest X-ray or EKG	2	2	--	--	--	--	9	54	--	--
Very, moderately, or somewhat sick (i.e., ASSC >= 3) or chest pain noted by MO or RN	EKG only	2	2	--	--	45	79	--	--	--	--
Laboratory Assessment											
Somewhat sick (i.e., ASSC 3-4)	At least 1 of 4 labs	1	1	--	--	17	53	13	42	--	--
	At least 3 of 7 labs	3	3	16	47	--	--	--	--	--	--
Moderately or very sick (i.e., ASSC >= 5)	At least 2 of 4 labs	2	2	--	--	12	62	9	55	--	--
	All 7 of 7 labs	7	7	7	15	--	--	--	--	--	--
Moderately or very sick (i.e., ASSC >= 5)	Cardiac enzymes	2	2	7	23	--	--	9	16	--	--
Chest pain noted by MO or RN	Cardiac isoenzymes	2	2	--	--	19	35	--	--	--	--
Moderately or very sick (i.e., ASSC >= 5)	Arterial blood gas	2	2	7	41	--	--	9	54	--	--
Very sick (i.e., ASSC >=4)	At least 4 of 7 labs	4	4	--	--	--	--	--	--	3	5
Moderately sick (i.e., ASSC = 2-3)	At least 3 of 7 labs	3	3	--	--	--	--	--	--	10	43
Use of ICU or telemetry											
Somewhat sick (i.e., ASSC 3-4)	ICU	2	2	--	--	--	--	13	19	--	--
	Telemetry	1	2	--	--	--	--	13	9	--	--
Moderately sick (i.e., ASSC 5-6)	ICU	3	3	5	43	--	--	6	33	--	--
	Telemetry	2	3	5	19	--	--	6	9	--	--
Very sick (i.e., ASSC >= 7)	ICU	7	7	2	69	--	--	3	65	--	--
	Telemetry	3	7	2	12	--	--	3	12	--	--
Very sick (i.e., ASSC >= 7)	ICU	7	7	--	--	5	94	--	--	--	--
	Telemetry	1	7	--	--	5	3	--	--	--	--
Moderately sick (i.e., ASSC 5-6)	ICU	6	6	--	--	7	90	--	--	--	--
	Telemetry	2	6	--	--	7	9	--	--	--	--
Somewhat sick (i.e., ASSC 3-4)	ICU	5	5	--	--	17	84	--	--	--	--
	Telemetry	2	5	--	--	17	13	--	--	--	--
Not very sick (i.e., ASSC 0-2) on day 3 and shock, congestive heart failure, or ASSC >=3 on day 2	ICU	5	5	--	--	19	85	--	--	--	--
	Telemetry	2	5	--	--	19	11	--	--	--	--
Not very sick (i.e., ASSC 0-2) on day 3 and evidence of AMI	ICU	4	4	--	--	41	75	--	--	--	--
	Telemetry	2	4	--	--	41	20	--	--	--	--
Not very sick (i.e., ASSC 0-2) on day 3 and no evidence of AMI	ICU	0	0	--	--	10	61	--	--	--	--
	Telemetry	0	0	--	--	10	27	--	--	--	--
Very sick (i.e., ASSC >=4) on day 3)	ICU	7	7	--	--	--	--	--	--	3	57
	Telemetry	--	--	--	--	--	--	--	--	--	--
Moderately sick (i.e., ASSC 2-3)	ICU	3	3	--	--	--	--	--	--	10	35
	Telemetry	--	--	--	--	--	--	--	--	--	--
Use of Medications											
If pO2 < 60	Use O2 or intubation	3	3	3	94	--	--	5	92	--	--
All CHF patients with systolic 8P >= 90	Use digitalis or diuretic	2	2	94	92	--	--	--	--	--	--
Moderately or very sick (i.e., ASSC >= 5) and S8P < 90 Day 3	Use pressors or IV unloading agents day 3	4	4	--	--	9	57	--	--	--	--
Ventricular tachycardia day 1 or 2 or PVCs Day 3	Use antiarrhythmics or oral or IV 8 blockers day 3	3	3	--	--	10	65	--	--	--	--
Hypertension day 2 and 3	Use IV unloading agents, long-acting nitrates, oral or IV 8 blockers, or Calcium channel blockers day 3	5	5	--	--	1	82	--	--	--	--
Chest pain noted by MO or RN day 3 and no IV unloading agents Day 3	Use short-acting nitrates day 3	1	1	--	--	26	54	--	--	--	--
Chest pain noted by MO or RN day 2 and day 3 and no evidence of shock or congestive heart failure day 1 or 2 and no IV unloading agents day 3	Use long-acting nitrates, oral or IV B blockers, or Calcium channel blockers blockers Day 3	3	3	--	--	10	80	--	--	--	--
Chest pain noted by MO or RN day 2 and 3 and evidence of shock or congestive heart failure day 1 or 2 and no IV unloading agents day 3	Use long-acting nitrates, or Calcium channel blockers day 3	3	3	--	--	8	78	--	--	--	--

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(1) There are no day 3 process criteria for hip fracture patients.
(2) Defines patients to whom process criteria are applicable.
(3) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(4) % of applicable patients who meet the process criteria.

Table C.26

PERFORMANCE ON ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH CONGESTIVE HEART FAILURE

(pre- and post-PPS combined)

Subset (1)	Process Measure	Assigned Points	Applic-able Points	Applicable Patients (2)	Patients Meeting Criteria (3)
If nonambulatory	Anticoagulate	1	1	4.5	14.8
If abnormal lab	Recheck within 3 days				
Na < 130 or >= 150		1	1	15.3	75.2
K < 3.0 or >= 5.5		1	1	17.1	81.2
Renal (Cr >= 2.0 or BUN >= 81)		1	1	22.8	66.6
HCO3 < 15 or >= 41		1	1	4.6	69.2
WBC < 3.0 or >= 15		1	1	12.8	53.6
HCT < 30		1	1	12.3	62.2
If abnormal laboratory value	Correct within 3 days				
Na < 130 or >= 150		1	1	15.3	49.7
K < 3.0 or >= 5.5		1	1	17.1	75.0
Renal (Cr >= 6.0 or BUN > 100)		1	1	3.5	36.0
HCO3 < 15 or >= 41		1	1	4.6	45.4
WBC >= 15		1	1	12.2	43.8
HCT < 30		1	1	12.3	36.6
New fever > 38.3 C Day 1 or later	Infection work-up: CXR, blood culture, and urine culture				
	3 of 3	3	3	8.4	24.2
	2 of 3	2	3	8.4	26.7
	1 of 3	1	3	8.4	33.1
	0 of 3	0	3	8.4	16.1

(1) Defines patients to whom process criteria are applicable.

(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of Applicable Patients who meet the Process Criteria.

Table C.27

PERFORMANCE ON ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

(pre- and post-PPS combined)

Subset (1)	Process Measure	Assigned Points	Applic-able Points	Applicable Patients(2)	Patients Meeting Criteria(3)
If abnormal lab	Recheck within 3 days				
Na < 130 or >= 150		1	1	15.9	75.4
K < 3.0 or >= 5.5		1	1	14.4	78.6
Renal (Cr >= 2.0 or BUN >= 81)		1	1	16.1	62.9
If abnormal laboratory value	Correct within 3 days				
Na < 130 or >= 150		1	1	15.8	57.5
K < 3.0 or >= 5.5		1	1	14.4	74.5
Renal (Cr >= 6.0 or BUN > 100)		1	1	2.1	41.0

(1) Defines patients to whom process criteria are applicable.

(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of applicable patients who meet the process criteria.

Table C.28

PERFORMANCE ON ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH PNEUMONIA

(pre- and post-PPS combined)

Subset (1)	Process Measure	Assigned Points	Applicable Points	Applicable Patients(2)	Patients Meeting Criteria(3)
If nonambulatory	Anticoagulate	1	1	14.7	6.2
If abnormal lab	Recheck within 3 days				
Na < 130 or >= 150		1	1	19.3	73.0
K < 3.0 or >= 5.5		1	1	14.9	76.8
Renal (Cr >= 2.0 or BUN >= 81)		1	1	14.4	67.2
If abnormal laboratory value	Correct within 3 days				
Na < 130 or >= 150		1	1	19.3	50.9
K < 3.0 or >= 5.5		1	1	14.9	69.2
Renal (Cr >= 6.0 or BUN > 100)		1	1	2.4	46.2
All hospitalized patients	Weigh patient				
>= 2 times		2	2	100	42.8
Once		1	2	100	21.4
Never		0	2	100	35.8
New or persistent fever > 38.3 C day 4 or later	Obtain blood culture	1	1	8.4	32.2
	Obtain urinalysis or urine culture	1	1	8.4	39.1
Sputum sent for culture	Sputum gram stain quality noted	1	1	2.7	60.3
New or persistent fever > 38.3 C day 4 or later	Change antibiotics for nonimmunocompromised patients	5	5	7.3	45.3
	Change antibiotics for immunocompromised patients	7	7	1.1	48.3

(1) Defines patients to whom process criteria are applicable.

(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of applicable patients who meet the process criteria.

Table C.29

PERFORMANCE ON ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH CEREBROVASCULAR ACCIDENT

(pre- and post-PPS combined)

Subset (1)	Process Measure	Assigned Points	Applic-able Points	Applicable Patients(2)	Patients Meeting Criteria(3)
If abnormal lab	Recheck within 3 days				
Na < 130 or >= 150		1	1	15.6	71.4
K < 3.0 or >= 5.5		1	1	12.3	77.8
Renal (Cr >= 2.0 or BUN >= 81)		1	1	11.2	58.7
HC03 < 15 or >= 41		1	1	2.3	58.5
WBC < 3.0 or >= 15		1	1	18.9	50.5
HCT < 30		1	1	8.0	59.3
If abnormal laboratory value	Correct within 3 days				
Na < 130 or >= 150		1	1	15.6	45.9
K < 3.0 or >= 5.5		1	1	12.3	70.3
Renal (Cr >= 6.0 or BUN > 100)		1	1	1.8	41.2
HC03 < 15 or >= 41		1	1	2.3	46.2
WBC >= 15		1	1	18.4	29.7
HCT < 30		1	1	7.9	35.0

(1) Defines patients to whom process criteria are applicable.

(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of Applicable Patients who meet the Process Criteria.

Table C.30

PERFORMANCE ON ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH HIP FRACTURE

(pre- and post-PPS combined)

Subset (1)	Process Measure	Assigned Points	Applicable Points	Applicable Patients(2)	Patients Meeting Criteria(3)
If abnormal lab	Recheck within 3 days				
Na < 130 or >= 150		1	1	14.6	71.9
K < 3.0 or >= 5.5		1	1	8.1	74.9
Renal (Cr >= 2.0 or BUN >= 81)		1	1	5.4	66.0
WBC < 3.0 or >= 15		1	1	14.1	68.1
HCT < 30		1	1	51.6	81.6
If abnormal laboratory value	Correct within 3 days				
Na < 130 or >= 150		1	1	14.6	44.3
K < 3.0 or >= 5.5		1	1	8.1	68.2
Renal (Cr >= 6.0 or BUN > 100)		1	1	1.2	36.4
WBC >= 15		1	1	13.6	46.8
HCT < 30		1	1	51.6	57.6
New fever > 38.3 C Excluding postop days 1 & 2	Infection work-up: CXR, Blood culture, and urine culture				
	3 of 3	3	3	10.1	17.2
	2 of 3	2	3	10.1	27.6
	1 of 3	1	3	10.1	39.4
	0 of 3	0	3	10.1	15.8

(1) Defines patients to whom process criteria are applicable.

(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of applicable patients who meet the process criteria.

Table C.31

PERIOP PATIENT PROCESS (SURGERY PATIENTS ONLY) FOR HIP FRACTURE PATIENTS (Pre- and Post-PPS Combined)

				HIP % of Patients	
Subsets(1)	Process Measure	Assigned Points	Applicable Points	Applicable Patients(2)	Patients Meeting Criteria(3)
All Surgical Patients	Parenteral Antibiotics	3	3	100	77
Surgical Patients with Temperature < 101 F (38.3 C) on postop Days 2,3 & 4, no postop hip infection, no preop or postop pneumonia, and WBC < 15 or not tested on postop days 2,3 & 4	No parenteral antibiotics on postop days 1, 2,3 & 4	2	2	57	9
Surgical Patients treated with internal fixation or pinning	Hip x-ray day of surgery	2	2	58	100
Surgical Patients treated with arthroplasty	Hip x-ray day of surgery or postop day 1 or 2	2	2	39	67
All Surgical Patients	Hematocrit (or Hemoglobin) Day of Surgery or postop Day 1	1	1	100	90
Surgical Patients with Chest Pain or shortness of breath preop on day prior to surgery or day of surgery	EKG Day prior to surgery or day of surgery	2	2	5	78
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 2	BP measured at least 5 times on postop Day 2	1	1	3	66
Surgical Patients not very, somewhat, or moderately sick (i.e., ASSC = 0-2) on postop Day 2	BP measured at least 3 times on postop day 2	1	1	96	76
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 1 or 2	CXR or EKG on postop Day 1 or 2	2	2	6	38
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 1 or 2	At least 4 of 6 labs (BUN, Cr, Na, K, WBC, HCT) on postop Day 1 or 2	4	4	6	65
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 1	ICU on postop Day 1	3	3	4	41
	Telemetry on postop Day 1	2	3	4	9
Surgical Patients Moderately sick (i.e., ASSC =2) on postop Day 1	ICU on postop Day 1	2	2	8	28
	Telemetry on postop Day 1	1	2	8	8
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 2	ICU postop on Day 2	3	3	3	34
	Telemetry on postop Day 2	2	3	3	7
Surgical Patients Moderately sick (i.e., ASSC =2) on postop Day 2	ICU postop on Day 2	2	2	7	20
	Telemetry on postop Day 2	1	2	7	3

(1) Defines patients to whom process criteria are applicable.

(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of Applicable Patients who meet the Process Criteria.

Table C.32

PERFORMANCE ON INITIAL COGNITIVE MD PROCESS CRITERIA ACROSS DISEASES
(Pre- vs Post-PPS)

			% of Patients Meeting Process Criteria									
			CHF		AMI		PNE		CVA		HIP	
Process Criteria (1)	Assigned Points	Applicable Points	Pre 1360	Post 1464	Pre 1416	Post 1437	Pre 1341	Post 1408	Pre 1382	Post 1442	Pre 1358	Post 1404
Within the first 2 hospital days physicians should document each of the following:												
Previous Cardiac History Noted	1	1			87	89						
Prior Cardiac History or Hypertension Noted	1	1							81	82		
Previous Pulmonary Disease Noted	1	1					58	63				
Past Surgeries Noted	1	1	61	66							75	77
Time of Onset of Symptoms Noted	1	1			95	96			91	94		
Sputum or Cough Noted	1	1					79	77				
Circumstances of Hip Injury Noted	1	1									98	98
Medications Noted	1	1	78	84	81	86	71	75	74	82	80	86
Allergies Noted	1	1	51	58	56	62						
Social or Family History Noted	1	1			64	64						
Prior Living Arrangements Noted	1	1									70	73
Alcoholism or Smoking Habits Noted	1	1			61	64					44	52
Alcohol Use Noted	1	1	42	47			40	44				
Tobacco Use Noted	1	1					47	52				
Prior CVA Noted	1	1							48	53		
Temperature Noted	1	1					76	79				
Mental Status Noted	1	1					61	65	83	83	68	70
Pupils Noted	1	1							80	82		
Jugular Veins Noted	1	1	63	70	61	68	41	48				
Gag Reflex Noted	1	1							35	38		
Carotid Bruits Noted	1	1							61	72		
Neck Noted	1	1									90	90
Heart Noted	1	1									98	98
Heart Sounds Noted	1	1	67	73	76	81			57	63		
Heart Murmurs Noted	1	1	78	80	84	84	76	76				
Lungs Noted	1	1									99	98
Abdomen Noted	1	1	97	98	97	97						
Muscle tone or Strength Noted	1	1							82	86		
Pedal or Leg Pulse Noted	1	1									62	67
Lower Extremity Edema Noted	1	1	91	92	78	82	68	75				
Limb Reflexes Noted	1	1							64	71		
SOB Assessed.D1H	1	1					66	74				
SOB Assessed.D2H	1	1					25	31				
Lung Exam Done.D1H	1	1	99	98	96	97	98	98				
Lung Exam Done.D2H	1	1	58	71	64	70	59	68				
Chest Pain Noted.D1H	1	1			94	94						
Chest Pain Noted.D2H	1	1			63	71						
Deficits Noted.D1H	1	1							99	99		
Deficits Noted.D2H	1	1							74	85		
MD Note.D1H	1	1							100	100		
MD Note.D2H	1	1							92	96		
Total Number of Process Criteria			11	11	15	15	14	14	15	15	10	10

(1) All patients are applicable.

Table C.33

PERFORMANCE ON INITIAL RN PROCESS CRITERIA BY DISEASES
(Pre- vs Post-PPS)

Process Criteria (1)	Assigned Points	Applicable Points	% of Patients Meeting Process Criteria									
			CHF		AMI		PNE		CVA		HIP	
Within the first 2 hospital days, nurses should document each of the following:			Pre n=1360	Post n=1464	Pre n=1416	Post n=1437	Pre n=1341	Post n=1408	Pre n=1382	Post n=1442	Pre n=1358	Post n=1404
SOB Assessed.D1H	1	1	88	93			67	78				
SOB Assessed.D2H	1	1	88	92			72	84				
Chest Pain Assessed.D1H	1	1			92	93						
Chest Pain Assessed.D2H	1	1			92	92						
PVCs Assessed.D1H	1	1			63	67						
PVCs Assessed.D2H	1	1			71	75						
Pupils Assessed.D1H	1	1							43	62		
Pupils Assessed.D2H	1	1							38	57		
Nutritional Intake Noted.D1H	1	1							63	62		
Nutritional Intake Noted.D2H	1	1							88	90		
Weight taken.D1H or D2H (2)	1	1			58	65						
Blood Pressure Taken >= 3 Times.D2H	1	1	78	84			69	79	79	86		
Monitor Strips >= 3.D1H	1	1			76	86						
Urinary Continence Noted	1	1	65	72			66	76	60	68	62	69
Ambulatory Status Noted	1	1	70	79			69	78	73	80	85	92
Preadmission Residence Noted	1	1	92	95	92	94	96	98	97	97	97	98
Total # of Process Criteria			6	6	7	7	6	6	8	8	3	3

(1) All patients are applicable.
(2) Applicable patients for AMI are those without shock or congestive heart failure on Day 1 and 2 (i.e., 74% Pre and 68% Post).

Table C.34

PERFORMANCE ON INITIAL CHEST X-RAY & ELECTROCARDIOGRAM PROCESS BY DISEASE (Pre- vs Post-PPS)

Disease	Patient Subset (1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
					Applicable Patients (2)	Patients Meeting Criteria (3)	Applicable Patients (2)	Patients Meeting Criteria (3)
CHF	All Patients Day 1 or 2	Chest x-ray	2	2	100	94	100	96
	All Patients Day 1 or 2	EKG	2	2	100	87	100	91
AMI	All Patients Day 1 or 2	Chest x-ray	3	3	100	91	100	93
	All Patients Day 1	EKG	3	3	100	94	100	97
	All Patients Day 2	EKG	3	3	100	90	100	91
PNE (4)	If moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	Chest x-ray	2	2	29	99	32	100
	If moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	EKG	2	2	29	77	32	75
CVA	All Patients Day 1 or 2	Chest x-ray	2	2	100	80	100	79
	All Patients Day 1 or 2	EKG	2	2	100	82	100	86
HIP	All Patients Day 1 or 2	Chest x-ray	2	2	100	92	100	93
	All Patients Day 1 or 2	EKG	2	2	100	90	100	93

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.
(4) Since pneumonia patients could have had a chest x-ray and EKG in the week prior to admission, these were required of only the sicker patients on Day 1 or 2

Table C.35

PERFORMANCE ON INITIAL LABORATORY ORDERING CRITERIA FOR BLOOD CHEMISTRY AND HEMATOLOGY STUDIES

(Pre- vs Post-PPS)

Process Criteria (1)	Assigned Points	Applicable Points	Applicable Patients	% of Patients Meeting Criteria									
Within the first 2 hospital				CHF		AMI		PNE		CVA		HIP	
days, physicians should order each of the following:				Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
								% of Patients					
Venous Bicarbonate	1	1	100	80	87	81	88	77	84	78	86	--	--
Creatinine	1	1	100	69	81	66	79	65	79	62	79	59	74
BUN	1	1	100	88	93	88	91	83	90	84	92	85	87
Sodium	1	1	100	93	97	92	95	86	93	88	94	88	92
Potassium	1	1	100	93	97	93	95	87	93	88	94	89	94
White Blood Count	1	1	100	92	94	94	96	99	98	94	95	96	97
Hematocrit	1	1	100	91	94	95	96	98	98	94	95	96	97
White Blood Count Differential	1	1	100	--	--	--	--	97	93	--	--	--	--

(1) All patients are applicable.

Table C.36

PERFORMANCE ON INITIAL LABORATORY ORDERING CRITERIA FOR CPK AND ARTERIAL BLOOD GAS BY DISEASE

(Pre- vs Post-PPS)

					% of Pre Patients		% of Post Patients	
Disease	Patient Subset (1)	Process Criteria	Assigned Points	Applicable Points	Applicable Patients (2)	Patients Meeting Criteria (3)	Applicable Patients (2)	Patients Meeting Criteria (3)
CHF	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	CPK Day 1 or 2	2	2	25	66	27	67
	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	ABG Day 1 or 2	2	2	25	72	27	78
AMI	All Patients Day 1	CPK or LDH Isoenzymes Day 1	4	4	100	40	100	49
		Total CPK Only Day 1	3	4	100	46	100	45
	All Patients Day 2	CPK or LDH Isoenzymes Day 2	3	3	100	51	100	56
		Total CPK Only Day 2	2	3	100	37	100	34
	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	ABG Day 1 or 2	2	2	33	67	36	74
PNE	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	CPK Day 1 or 2	2	2	29	35	32	34
	Moderately or very sick (i.e., ASSC >= 5) Day 1 or 2	ABG Day 1 or 2	2	2	29	70	32	80
CVA (4)	Moderately or very sick (i.e., ASSC >= 2) Day 1 or 2	ABG Day 1 or 2	2	2	27	47	26	57

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.
(4) ASSC for CVA is based on 5 components rather than the 7 components used for CHF, AMI, & PNE.

CHF: 8/10/88, 18:41, NV
AMI: 2/21/89, 18:11, JK

Table C.37

PERFORMANCE ON DAY 1 USE OF ICU AND TELEMETRY PROCESS CRITERIA (4)

(Pre- vs Post-PPS)

				CHF				AMI				PNE				CVA			
				Pre		Post		Pre		Post		Pre		Post		Pre		Post	
Patient Subsets(1)	Process Criteria	Assigned Points	Applicable Points	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)
Somewhat sick	CCU	2	2	-	-	-	-	-	-	-	-	28	7	30	9	-	-	-	-
(i.e., ASSC = 3-4)	Telemetry	1	2	-	-	-	-	-	-	-	-	28	4	30	10	-	-	-	-
Moderately sick	CCU	3	3	16	43	16	46	-	-	-	-	17	19	19	18	-	-	-	-
(i.e., ASSC = 5-6)	Telemetry	2	3	16	8	16	24	-	-	-	-	17	7	19	13	-	-	-	-
Very sick	CCU	7	7	5	61	6	71	-	-	-	-	9	42	11	50	-	-	-	-
(i.e., ASSC >= 7)	Telemetry	3	7	5	12	6	17	-	-	-	-	9	5	11	7	-	-	-	-
Cardiogenic	CCU	7	7	-	-	-	-	5	95	6	91	-	-	-	-	-	-	-	-
shock with	Telemetry	1	7	-	-	-	-	5	1	6	7	-	-	-	-	-	-	-	-
End Organ Damage																			
Arrhythmias, AND																			
very sick																			
(i.e., ASSC >= 7)																			
Shock OR very sick	CCU	7	7	-	-	-	-	14	88	17	89	-	-	-	-	-	-	-	-
(i.e., ASSC >= 7)	Telemetry	1	7	-	-	-	-	14	8	17	7	-	-	-	-	-	-	-	-
Moderately sick	CCU	6	6	-	-	-	-	8	83	9	82	-	-	-	-	-	-	-	-
(i.e., ASSC = 5-6)	Telemetry	2	6	-	-	-	-	8	9	9	15	-	-	-	-	-	-	-	-
Congestive Heart	CCU	6	6	-	-	-	-	8	80	8	80	-	-	-	-	-	-	-	-
Failure AND	Telemetry	2	6	-	-	-	-	8	10	8	14	-	-	-	-	-	-	-	-
Somewhat sick																			
(i.e., ASSC = 3-4)																			
Congestive Heart	CCU	5	5	-	-	-	-	11	77	11	75	-	-	-	-	-	-	-	-
Failure AND	Telemetry	2	5	-	-	-	-	11	14	11	19	-	-	-	-	-	-	-	-
Not very sick																			
(i.e., ASSC <= 2)																			
Somewhat sick	CCU	5	5	-	-	-	-	14	77	15	75	-	-	-	-	-	-	-	-
(i.e., ASSC = 3-4)	Telemetry	2	5	-	-	-	-	14	11	15	22	-	-	-	-	-	-	-	-
Not very sick	CCU	4	4	-	-	-	-	20	81	18	70	-	-	-	-	-	-	-	-
but some symptom	Telemetry	2	4	-	-			20	11	18	26	-	-	-	-	-	-	-	-
or sign																			
(i.e., ASSC = 2)																			
AMI With no more than	CCU	4	4	-	-	-	-	16	71	14	77	-	-	-	-	-	-	-	-
one symptom or sign	Telemetry	2	4	-	-	-	-	16	20	14	20	-	-	-	-	-	-	-	-
No Evidence of AMI	CCU	4	4	-	-	-	-	4	55	3	71	-	-	-	-	-	-	-	-
	Telemetry	3	4	-	-	-	-	4	23	3	29	-	-	-	-	-	-	-	-
Moderately sick	CCU	3	3	-	-	-	-	-	-	-	-	-	-	-	-	14	30	14	37
(i.e., ASSC = 2-3)	Telemetry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Very sick	CCU	7	7	-	-	-	-	-	-	-	-	-	-	-	-	7	54	5	58
(i.e., ASSC >= 4)	Telemetry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A. Applicable patients.
B. Patients meeting criteria.

(1) Defines patients to whom process criteria are applicable.
(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of applicable patients who meet the process criteria.
(4) Not applicable for hip fracture patients.

Table C.38

PERFORMANCE ON DAY 2 USE OF ICU AND TELEMETRY PROCESS CRITERIA (4)

(Pre- vs Post-PPS)

Patient Subsets(1)	Process Criteria	Assigned Points	Applicable Points	CHF				AMI				PNE				CVA			
				Pre		Post		Pre		Post		Pre		Post		Pre		Post	
				A(2)	8(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	B(3)	A(2)	8(3)
Somewhat sick (i.e., ASSC = 3-4)	CCU	2	2	-	-	-	-	-	-	-	-	16	19	18	17	-	-	-	-
	Telcmetry	1	2	-	-	-	-	-	-	-	-	16	5	18	11	-	-	-	-
Moderately sick (i.e., ASSC = 5-6)	CCU	3	3	6	49	7	41	-	-	-	-	8	31	8	35	-	-	-	-
	Telemetry	2	3	6	13	7	31	-	-	-	-	8	4	8	12	-	-	-	-
Very sick (i.e., ASSC >= 7)	CCU	7	7	2	60	2	69	-	-	-	-	4	52	4	53	-	-	-	-
	Telemetry	3	7	2	10	2	22	-	-	-	-	4	11	4	17	-	-	-	-
Cardiogenic shock with End Organ Damage Arrhythmias, AND very sick (i.e., ASSC >= 7)	CCU	7	7	-	-	-	-	4	94	4	98	-	-	-	-	-	-	-	-
	Telemetry	1	7	-	-	-	-	4	6	4	2	-	-	-	-	-	-	-	-
Shock OR very sick (i.e., ASSC >= 7)	CCU	7	7	-	-	-	-	11	92	16	87	-	-	-	-	-	-	-	-
	Telemetry	1	7	-	-	-	-	11	5	16	10	-	-	-	-	-	-	-	-
Moderately sick (i.e., ASSC = 5-6)	CCU	6	6	-	-	-	-	3	89	4	85	-	-	-	-	-	-	-	-
	Telemetry	2	6	-	-	-	-	3	11	4	9	-	-	-	-	-	-	-	-
Congestive Heart Failure AND Somewhat sick (i.e., ASSC = 3-4)	CCU	6	6	-	-	-	-	2	80	3	93	-	-	-	-	-	-	-	-
	Telemetry	2	6	-	-	-	-	2	12	3	5	-	-	-	-	-	-	-	-
Congestive Heart Failure AND Not very sick (i.e., ASSC <= 2)	CCU	5	5	-	-	-	-	7	91	7	89	-	-	-	-	-	-	-	-
	Telemetry	2	5	-	-	-	-	7	5	7	10	-	-	-	-	-	-	-	-
Somewhat sick (i.e., ASSC = 3-4)	CCU	5	5	-	-	-	-	11	86	10	82	-	-	-	-	-	-	-	-
	Telcmetry	2	5	-	-	-	-	11	7	10	15	-	-	-	-	-	-	-	-
No shock or congestive heart failure or somewhat, moderately, or very sick (i.e., ASSC >= 1) Day 1	CCU	5	5	-	-	-	-	30	77	29	78	-	-	-	-	-	-	-	-
	Telemetry	2	5	-	-	-	-	30	14	29	18	-	-	-	-	-	-	-	-
Not very sick but some symptom or sign (i.e., ASSC = 2) Day 2	CCU	4	4	-	-	-	-	4	88	3	78	-	-	-	-	-	-	-	-
	Telemetry	2	4	-	-	-	-	4	4	3	22	-	-	-	-	-	-	-	-
AMI with no more than one symptom or sign (i.e., ASSC = 0-1) Day 2 and no shock, congestive heart failure, and not very sick (i.e., ASSC = 0-2) Day 1	CCU	4	4	-	-	-	-	24	76	20	75	-	-	-	-	-	-	-	-
	Telcmetry	3	4	-	-	-	-	24	17	20	24	-	-	-	-	-	-	-	-
No Evidence of AMI with no more than one symptom or sign (i.e., ASSC = 0-1)	CCU	4	4	-	-	-	-	5	65	4	67	-	-	-	-	-	-	-	-
	Telemetry	3	4	-	-	-	-	5	20	4	32	-	-	-	-	-	-	-	-
Moderately sick (i.e., ASSC = 2-3)	CCU	1	1	-	-	-	-	-	-	-	-	-	-	-	-	12	35	12	39
	Telemetry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Very sick (i.e., ASSC > 4)	CCU	7	7	-	-	-	-	-	-	-	-	-	-	-	-	5	48	4	54
	Telemetry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A. Applicable patients.
B. Patients meeting criteria.

(1) Defines patients to whom process criteria are applicable.
(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of applicable patients who meet the process criteria.
(4) Not applicable for hip fracture patients.

Table C.39

PERFORMANCE ON INITIAL PROCESS FOR USE OF MEDICATIONS AND SPECIAL PROCEDURES FOR AMI

(Pre- vs Post-PPS)

Patient Subsets (1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
Cardiogenic shock with End Organ Damage, Arrhythmias, AND Very sick (i.e., ASSC >= 7) Day 1 or 2	Use Swan Ganz Catheter Day 1 or 2	4	4	7	31	8	38
Cardiogenic shock with End Organ Damage, Arrhythmias, AND Very sick (i.e., ASSC >= 7) Day 1	Use Pressors or IV unloading agents Day 1	5	5	5	71	6	76
Cardiogenic shock with End Organ Damage, Arrhythmias, AND Very sick (i.e., ASSC >= 7) Day 2	Use Pressors or IV unloading agents Day 2	5	5	4	65	4	85
Ventricular tachycardia Day 1	Use Antiarrhythmics Day 1	7	7	1	100	1	88
PVCs Day 1	Use Antiarrhythmics Day 1	4	4	24	69	22	69
Ventricular tachycardia Day 2	Use Antiarrhythmics Day 2	7	7	1	62	1	80
PVCs Day 2	Use Antiarrhythmic Day 2	4	4	17	62	18	65
Third degree heart block Day 1 or 2 AND Anterior AMI	Use Pacemaker Day 1 or 2	7	7	1	92	1	62

Table C.39 (continued)

Patient Subsets (1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
Third degree heart block Day 1 or 2 but no Anterior AMI	Use Pacemaker Day 1 or 2	4	4	2	44	3	78
Patient given streptokinase	Note on Bleeding History	1	1	1	0	4	14
Patient given streptokinase	Streptokinase given within 6 hours of time symptoms 1st noted	5	5	1	40	3	72
Congestive heart failure but no shock Day 1	Use loop diuretics Day 1	5	5	19	51	19	54
Congestive heart failure but no shock Day 2	Use loop diuretics Day 2	5	5	8	63	10	70
Hypertension Day 1 and 2	Use IV unloading agents Long-acting nitrates, oral or IV B blockers, OR Ca channel blockers Day 2	5	5	3	56	2	88
Chest pain noted by MD or RN Day 2 and no IV unloading agents Day 2	Use short-acting nitrates Day 2	1	1	41	54	30	54
Chest pain noted by MD or RN Day 1 and 2 AND no evidence of shock or congestive heart failure Day 1 and 2 AND no IV unloading agents Day 2	Use long-acting nitrates, oral or IV B blockers, OR Ca channel blockers Day 2	3	3	23	67	16	81

Table C.39 (continued)

Patient Subsets (1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
Chest pain noted by MD or RN Day 1 and 2 AND no evidence of shock or congestive heart failure Day 1 or 2 AND no IV unloading agents Day 2	Use long-acting nitrates, or Ca channel blockers Day 2	3	3	17	65	13	78

(1) Defines patients to whom process criteria are applicable.
(2) % of patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of applicable patients who meet the process criteria.

Table C.40

PERFORMANCE OF DAY 3 PROCESS CRITERIA FOR PATIENTS WITH CONGESTIVE HEART FAILURE (Pre- vs Post-PPS)

Process Scale & Patient Subset(1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
MD Assessment							
All Patients	SOB assessed	1	1	100	45	100	54
	Lung assessed	1	1	100	60	100	69
RN Assessment							
All Patients	SOB assessed	1	1	100	85	100	91
Chest x-ray & Electrocardiogram							
Moderately or Very Sick (i.e., ASSC >= 5)	Chest x-ray only	2	2	6	41	7	29
	EKG only	2	2	6	46	7	32
Laboratory Assessment							
Somewhat sick (i.e., ASSC 3-4)	At least 3 of 7 labs	3	3	14	38	17	54
Moderately or Very Sick (i.e., ASSC >= 5)	All 7 of 7 labs	7	7	6	14	7	16
Moderately or Very Sick (i.e., ASSC >= 5)	Cardiac enzymes	2	2	6	28	7	18
Moderately or Very Sick (i.e., ASSC >= 5)	Arterial blood gas	2	2	6	42	7	39
Use of ICU or Telemetry							
Moderately Sick (i.e., ASSC 5-6)	ICU	3	3	5	47	5	39
	Telemetry	2	3	5	13	5	26
Very Sick (i.e., ASSC >= 7)	ICU	7	7	1	82	2	61
	Telemetry	3	7	1	0	2	19
Use of Medications							
If p02 < 60	Use 02 or intubation	3	3	2	87	4	98
All CHF patients with systolic BP >= 90	Use digitalis or diuretic	2	2	95	91	93	92

(1) Defines patients to whom process criteria are applicable.

(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of Applicable Patients who meet the Process Criteria.

Table C.41

PERFORMANCE OF DAY 3 PROCESS CRITERIA FOR PATIENTS WITH ACUTE MYOCARDIAL INFARCTION (Pre- vs Post-PPS)

Process Scale & Patient Subset(1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
MD Assessment All Patients	Lung assessed	1	1	100	64	100	70
	Chest Pain assessed	1	1	100	60	100	70
RN Assessment All Patients	Chest Pain assessed	1	1	100	91	100	92
	PVCs assessed	1	1	100	69	100	71
Chest x-ray & Electrocardiogram Moderately or Very Sick (i.e., ASSC >= 5)	Chest x-ray only	2	2	10	51	13	59
Very, moderately, or somewhat sick (i.e., ASSC >= 3) or chest pain noted by MD or RN	EKG only	2	2	45	81	46	78
Laboratory Assessment Somewhat sick (i.e., ASSC 3-4)	At least 1 of 4 labs	1	1	17	54	16	52
Moderately or Very Sick (i.e., ASSC >= 5)	At least 2 of 4 labs	2	2	10	52	13	71
Chest Pain noted by MD or RN	Cardiac isoenzymes	2	2	18	38	21	32

Table C.41 (continued)

PERFORMANCE OF DAY 3 PROCESS CRITERIA FOR PATIENTS WITH ACUTE MYOCARDIAL INFARCTION
(Pre- vs Post-PPS)

Process Scale & Patient Subset(1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
Use of ICU or Telemetry							
Very Sick (i.e., ASSC >= 7)	ICU	7	7	4	94	5	94
	Telemetry	1	7	4	4	5	3
Moderately Sick (i.e., ASSC 5-6)	ICU	6	6	7	90	8	89
	Telemetry	2	6	7	10	8	8
Somewhat Sick (i.e., ASSC 3-4)	ICU	5	5	17	87	16	80
	Telemetry	2	5	17	9	16	16
Not Very Sick (i.e., ASSC 0-2) on day 3 and shock, congestive heart failure, or ASSC >=3 on day 2	ICU	5	5	18	84	21	85
	Telemetry	2	5	18	9	21	13
Not Very Sick (i.e., ASSC 0-2) on day 3 and evidence of AMI	ICU	4	4	43	77	40	73
	Telemetry	2	4	43	15	40	24
Not Very Sick (i.e., ASSC 0-2) on day 3 and no evidence of AMI	ICU	0	0	12	62	9	59
	Telemetry	0	0	12	21	9	35

Table C.41 (continued)

PERFORMANCE OF DAY 3 PROCESS CRITERIA FOR PATIENTS WITH ACUTE MYOCARDIAL INFARCTION
(Pre- vs Post-PPS)

Process Scale & Patient Subset(1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
Use of Medications							
Moderately or Very Sick (i.e., ASSC >=5) and SBP <90 Day 3	Use Pressors or IV unloading agents Day 3	4	4	7	52	10	61
Ventricular tachycardia Day 1 or Day 2 or PVC's Day 3	Use antiarrhythmics or oral of IV B Blockers Day 3	3	3	10	68	10	63
Hypertension Day 2 and 3	Use IV unloading agents, long-acting nitrates, oral or IV B blockers, or Ca channel blockers Day 3	5	5	1	78	1	88
Chest pain noted by MD or RN Day 3 and no IV unloading agents Day 3	Use short-acting nitrates Day 3	1	1	27	59	24	47
Chest pain noted by MD or RN Day 2 and Day 3 and no evidence of shock or congestive heart failure Day 1 or 2 and no IV unloading agents Day 3	Use long-acting nitrates, oral or IV B blockers, or Ca channel blockers Day 3	3	3	12	73	8	91
Chest pain noted by MD or RN Day 2 and 3 and evidence of shock or congestive heart failure Day 1 or 2 and no IV unloading agents Day 3	Use long-acting nitrates, or Ca channel blockers Day 3	3	3	8	71	8	84

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.

Table C.42

PERFORMANCE OF DAY 3 PROCESS CRITERIA FOR PATIENTS WITH PNEUMONIA
(Pre- vs Post-PPS)

Process Scale & Patient Subset(1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
MD Assessment							
All Patients	SOB assessed	1	1	100	21	100	27
	Lung assessed	1	1	100	59	100	65
RN Assessment							
All Patients	SOB assessed	1	1	100	72	100	83
Chest x-ray & Electrocardiogram							
Moderately or Very Sick (i.e., ASSC >= 5)	Either chest x-ray or EKG	2	2	9	51	9	56
Laboratory Assessment							
Somewhat sick (i.e., ASSC 3-4)	At least 1 of 4 labs	1	1	12	43	14	42
Moderately or Very Sick (i.e., ASSC >= 5)	At least 2 of 4 labs	2	2	9	55	9	55
Moderately or Very Sick (i.e., ASSC >= 5)	Cardiac enzymes	2	2	9	16	9	16
Moderately or Very Sick (i.e., ASSC >= 5)	Arterial blood gas	2	2	9	48	9	59
Use of ICU or Telemetry							
Somewhat Sick (i.e., ASSC 3-4)	ICU	2	2	12	22	14	16
	Telemetry	1	2	12	7	14	11
Moderately Sick (i.e., ASSC 5-6)	ICU	3	3	7	30	6	36
	Telemetry	2	3	7	9	6	9
Very Sick (i.e., ASSC >= 7)	ICU	7	7	2	55	3	72
	Telemetry	3	7	2	17	3	8
Use of Medications							
If p02 < 60	Use 02 or intubation	3	3	4	93	5	90

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.

PNE: 11/16/88, 20:30, NV; D3H n=2646

Table C.43

PERFORMANCE OF DAY 3 PROCESS CRITERIA FOR PATIENTS WITH CEREBROVASCULAR ACCIDENT
(Pre- vs Post-PPS)

Process Scale & Patient Subset(1)	Process Criteria	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
MD Assessment							
All Patients	Lung assessed	1	1	100	29	100	41
	MD note	1	1	100	91	100	96
	Note on deficit	1	1	100	68	100	78
RN Assessment							
All Patients	Nutrition assessed	1	1	100	88	100	90
	Pupils assessed	1	1	100	31	100	49
Laboratory Assessment							
Very Sick (i.e., ASSC >=4)	At least 4 of 7 labs	4	4	4	50	3	51
Moderately Sick (i.e., ASSC = 2-3)	At least 3 of 7 labs	3	3	10	47	10	38
Use of ICU or Telemetry							
Very Sick (i.e., ASSC >=4)	ICU	7	7	4	58	3	56
	Telemetry	--	--	--	--	--	--
Moderately Sick (i.e., ASSC 2-3)	ICU	3	3	10	34	10	36
	Telemetry	--	--	--	--	--	--

(1) Defines patients to whom process criteria are applicable.

(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of Applicable Patients who meet the Process Criteria.

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Table C.44

PERFORMANCE OF ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH CONGESTIVE HEART FAILURE

(Pre- vs Post-PPS)

Subset (1)	Process Measure	Assigned Points	Applicable Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
If nonambulatory	Anticoagulate	1	1	4.2	15.8	4.8	14.1
If Abnormal lab	Recheck within 3 days						
Na < 130 or >= 150		1	1	14.6	74.4	15.8	75.9
K < 3.0 or >= 5.5		1	1	16.7	80.2	17.5	82.1
Renal (Cr >= 2.0 or BUN >= 81)		1	1	20.8	63.6	24.6	68.9
HCO3 < 15 or >= 41		1	1	4.1	62.5	5.1	74.3
WBC < 3.0 or >= 15		1	1	11.3	44.2	14.2	60.6
HCT < 30		1	1	10.4	57.4	14.1	65.5
If Abnormal Laboratory Value	Correct within 3 days						
Na < 130 or >= 150		1	1	14.6	47.7	15.8	51.3
K < 3.0 or >= 5.5		1	1	16.7	70.9	17.5	78.6
Renal (Cr >= 6.0 or BUN > 100)		1	1	4.1	44.6	3.0	25.0
HCO3 < 15 or >= 41		1	1	4.1	41.1	5.1	48.6
WBC >= 15		1	1	10.7	39.0	13.6	47.2
HCT < 30		1	1	10.4	32.6	14.1	39.3
New Fever > 38.3 C Day 1 or later	Infection Work-up: CXR, Blood culture, and urine culture						
	3 of 3	3	3	8.7	26.3	8.1	22.0
	2 of 3	2	3	8.7	16.9	8.1	36.4
	1 of 3	1	3	8.7	39.8	8.1	26.3
	0 of 3	0	3	8.7	16.9	8.1	15.3

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.

Table C.45

PERFORMANCE OF ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

(Pre- vs Post-PPS)

				% of Pre Patients		% of Post Patients	
Subset (1)	Process Measure	Assigned Points	Applicable Points	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
If Abnormal lab	Recheck within 3 days						
Na < 130 or >= 150		1	1	16.2	73.0	15.7	77.8
K < 3.0 or >= 5.5		1	1	15.2	80.0	13.6	77.0
Renal (Cr >= 2.0 or BUN >= 81)		1	1	13.8	49.7	18.3	72.6
If Abnormal Laboratory Value	Correct within 3 days						
Na < 130 or >= 150		1	1	16.0	57.3	15.7	57.8
K < 3.0 or >= 5.5		1	1	15.2	75.3	13.6	73.5
Renal (Cr >= 6.0 or BUN > 100)		1	1	1.8	40.0	2.5	41.7

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.

Table C.46

PERFORMANCE OF ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH PNEUMONIA

(Pre- vs Post-PPS)

Subset (1)	Process Measure	Assigned Points	Applic-able Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
If nonambulatory	Anticoagulate	1	1	13.1	6.3	16.1	6.2
If Abnormal lab	Recheck within 3 days						
Na < 130 or >= 150		1	1	18.4	70.9	20.1	74.9
K < 3.0 or >= 5.5		1	1	14.3	74.6	14.8	78.8
Renal (Cr >= 2.0 or BUN >= 81)		1	1	13.0	68.4	15.8	66.2
If Abnormal Laboratory Value	Correct within 3 days						
Na < 130 or >= 150		1	1	18.3	47.4	20.1	54.1
K < 3.0 or >= 5.5		1	1	15.0	65.2	14.8	73.1
Renal (Cr >= 6.0 or BUN > 100)		1	1	2.2	41.4	2.6	50.0
All Hospitalized Patients	Weigh Patient						
>= 2 times		2	2	100	43.7	100	42.0
Once		1	2	100	20.1	100	22.7
Never		0	2	100	36.2	100	35.4
New or Persistent Fever > 38.3 C day 4 or later	Obtain blood culture	1	1	9.1	27.0	7.7	38.0
	Obtain urinalysis or urine culture	1	1	9.1	36.9	7.7	41.7
Sputum sent for culture	Sputum gram stain quality noted	1	1	3.1	57.1	2.2	64.5
New or persistent fever > 38.3 C day 4 or later	Change antibiotics for nonimmunocompromised patients	5	5	8.0	42.1	6.7	48.9
	Change antibiotics for immunocompromised patients	7	7	1.1	46.7	1.0	50.0

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.

Table C.47

PERFORMANCE OF ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH CEREBROVASCULAR ACCIDENT

(Pre- vs Post-PPS)

Subset (1)	Process Measure	Assigned Points	Applic-able Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
If Abnormal lab	Recheck within 3 days						
Na < 130 or >= 150		1	1	17.3	66.9	13.9	76.6
K < 3.0 or >= 5.5		1	1	13.5	76.3	11.2	79.5
Renal (Cr >= 2.0 or BUN >= 81)		1	1	11.6	53.4	10.8	64.1
HCO3 < 15 or >= 41		1	1	2.1	51.7	2.5	63.9
WBC < 3.0 or >= 15		1	1	17.6	46.9	20.2	53.4
HCT < 30		1	1	7.2	52.0	8.7	65.1
If Abnormal Laboratory Value	Correct within 3 days						
Na < 130 or >= 150		1	1	17.6	44.0	14.2	49.3
K < 3.0 or >= 5.5		1	1	13.8	68.1	11.3	73.6
Renal (Cr >= 6.0 or BUN > 100)		1	1	2.1	44.8	1.7	45.8
HCO3 < 15 or >= 41		1	1	2.4	57.6	2.6	47.4
WBC >= 15		1	1	16.9	26.1	19.9	32.8
HCT < 30		1	1	7.2	36.4	8.7	34.1

(1) Defines patients to whom process criteria are applicable.

(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.

(3) % of Applicable Patients who meet the Process Criteria.

Table C.48

PERFORMANCE OF ADDITIONAL PROCESS CRITERIA FOR SPECIAL SUBSETS OF PATIENTS WITH HIP FRACTURE

(Pre- vs Post-PPS)

Subset (1)	Process Measure	Assigned Points	Applic-able Points	% of Pre Patients		% of Post Patients	
				Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
If Abnormal lab	Recheck within 3 days						
Na < 130 or >= 150		1	1	15.8	64.7	13.3	80.2
K < 3.0 or >= 5.5		1	1	8.4	69.3	7.8	80.7
Renal (Cr >= 2.0 or BUN >= 81)		1	1	5.1	59.4	5.8	71.6
WBC < 3.0 or >= 15		1	1	14.5	61.9	13.7	74.5
HCT < 30		1	1	48.7	80.1	54.3	83.0
If Abnormal Laboratory Value	Correct within 3 days						
Na < 130 or >= 150		1	1	15.8	39.1	13.3	50.3
K < 3.0 or >= 5.5		1	1	8.4	64.0	7.8	72.5
Renal (Cr >= 6.0 or BUN > 100)		1	1	1.3	47.1	1.1	25.0
WBC >= 15		1	1	14.0	43.2	13.2	50.5
HCT < 30		1	1	48.7	56.9	54.3	58.2
New Fever > 38.3 C Excluding postop days 1 & 2	Infection Work-up: CXR, Blood culture, and urine culture						
	3 of 3	3	3	11.0	16.8	9.3	17.7
	2 of 3	2	3	11.0	24.8	9.3	30.8
	1 of 3	1	3	11.0	41.6	9.3	36.9
	0 of 3	0	3	11.0	16.8	9.3	14.6

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.

Table C.49

PERIOP PATIENT PROCESS (SURGERY PATIENTS ONLY) FOR HIP FRACTURE PATIENTS

(Pre- versus Post-PPS)

				% of Pre Patients		% of Post Patients	
Subsets(1)	Process Measure	Assigned Points	Applicable Points	Applicable Patients(2)	Patients Meeting Criteria(3)	Applicable Patients(2)	Patients Meeting Criteria(3)
All Surgical Patients	Parenteral Antibiotics	3	3	100	72	100	83
Surgical Patients with Temperature < 101 F (38.3 C) on postop Days 2,3 & 4, no postop hip infection, no preop or postop pneumonia, and WBC < 15 or not tested on postop days 2,3 & 4	No parenteral antibiotics on postop days 1, 2,3 & 4	2	2	51	9	63	9
Surgical Patients treated with internal fixation or pinning	Hip x-ray day of surgery	2	2	59	100	57	100
Surgical Patients treated with arthroplasty	Hip x-ray day of surgery or postop day 1 or 2	2	2	38	64	39	71
All Surgical Patients	Hematocrit (or Hemoglobin) Day of Surgery or postop Day 1	1	1	100	88	100	92
Surgical Patients with Chest Pain or shortness of breath preop on day prior to surgery or day of surgery.	EKG Day prior to surgery or day of surgery	2	2	4	67	6	84
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 2	BP measured at least 5 times on postop Day 2	1	1	3	66	3	66
Surgical Patients not very, somewhat, or moderately sick (i.e., ASSC = 0-2) on postop Day	BP measured at least 3 times on postop day 2	1	1	96	70	96	81
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 1 or 2	CXR or EKG on postop Day 1 or 2	2	2	4	52	6	27
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 1 or 2	At least 4 of 6 labs (BUN, Cr, Na, K, WBC, HCT) on postop Day 1 or 2	4	4	4	66	6	65
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 1	ICU on postop Day 1 Telemetry on postop day 1	3 2	3 3	2 2	49 2	4 4	35 15
Surgical Patients Moderately sick (i.e., ASSC =2) on postop Day 1	ICU on postop Day 1 Telemetry on postop Day 1	2 1	2 2	8 8	29 3	7 7	27 12
Surgical Patients Very sick (i.e., ASSC >=3) on postop Day 2	ICU on postop Day 2 Telemetry on postop Day 2	3 2	3 3	3 3	43 3	3 3	25 11
Surgical Patients Moderately sick (i.e., ASSC =2) on postop Day 2	ICU on postop Day 2 Telemetry on postop Day 2	2 1	2 2	7 7	21 1	7 7	19 6

(1) Defines patients to whom process criteria are applicable.
(2) % of Patients to whom criteria are applicable is the fraction of patients with each disease who fit the listed definition of patient subsets.
(3) % of Applicable Patients who meet the Process Criteria.

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For the aggregated process measures, we based our scale construction on a Likert Scaling model. This consisted of adding counts of related activities that had been performed. The model assumes that each process criteria represents the process concept imperfectly. Under this statistical model, the items will be correlated with each other and with the unmeasured conceptual value. For example, whether or not the physician determined what medications the patient was taking is correlated both with whether or not the physician determined any past surgeries and with the concept of initial MD assessment. Our disease-specific process scales are not the same as the unmeasured conceptual values, but are correlated with them.

Based on the average correlation between the items, it is possible to estimate the correlation between the summed measure and the underlying conceptual value. This is called the inter-item "reliability."

The three scales described are suitable for constructing reliability estimates. Scale reliabilities for the initial MD cognitive assessment, RN assessment, and lab process scales are excellent for all the diseases (Table C.50).

Reliabilities range from 0 to 1 (since they are correlation coefficients), and values above 0.5 are generally considered good for research purposes. If reliabilities are lower, then it is easier for the scale to measure peculiarities of the individual items that make up the scale. Also, there is less statistical precision to show effects that PPS or other reforms may have achieved through changes in the process of care. If a reliability is only 0.5, the best R-squared we could hope to find in a predictive regression is 0.25.

A spot check suggests other reliabilities are also good. For example, the two-item initial chest X-ray/electrocardiogram (EKG) measure has a reliability of 0.60 for CHF, and the three-item medication scale for CHF has a reliability of 0.97. Scales consisting of two or fewer items generally show lower reliabilities even though they may make clinical sense as a scale. For example, for PNE, the day 3 MD cognitive assessment process has only two items: MD assess shortness of breath and MD examine lungs. Its reliability is only 0.30. In certain cases, we cannot even estimate a reliability. For example, for PNE day 3 nursing care there is only one measurement: RN assess shortness of breath. Using the initial nursing items, we might guess that reliability for subsequent RN assessment is about 0.4.

Table C.50

SOME INITIAL SCALE RELIABILITIES ACROSS DISEASES

Disease	Initial MD Cognitive Assessment	Initial RN Assessment	Initial Laboratory Assessment
Congestive heart failure	0.83	0.58	0.87
Acute myocardial infarction	0.85	0.71	0.93
Hip Fracture	0.68	0.82	0.90
Pneumonia	0.71	0.63	0.84

We measure only a few of the multitude of processes that occur during the hospital stay. How do we know if the processes we measure are representative of the concept of all inhospital processes? If the process measures correlate with each other, they are likely to be measuring similar concepts. If they are uncorrelated, then they are measuring different concepts.

Using reliabilities for PNE patients listed in Table C.50, we can calculate the expected intercorrelation for initial MD cognitive assessment (reliability = 0.71) and initial RN assessment (reliability = 0.63). We would expect a correlation of (0.71) (0.63) = 0.45 if the two process scales were different measures of the same concept. In fact, we observed only 0.16 correlation suggesting initial MD cognitive assessment and initial RN assessment measure different process concepts.

In contrast, initial MD cognitive assessment scales correlate well with subsequent MD cognitive assessment scales. For example, for PNE, the expected correlation of initial MD cognitive assessment and subsequent MD cognitive assessment, (0.71) × (0.30) = 0.21, is lower than the observed intercorrelation of 0.39. The same is true when comparing initial and subsequent RN scales. The expectation using initial RN reliability × subsequent RN reliability, (0.63) × (approximately 0.4) = 0.24, is less than the observed intercorrelation of 0.30.

Table C.51 lists observed intercorrelations for PNE. There appears to be clinical validity to the intercorrelation values. The higher intercorrelations occur where we would expect, where processes are more likely to be measuring the same concept. For example, initial MD cognitive and RN scales correlate well with subsequent MD and RN scales (0.39 and 0.30,

Table C.51

INTERCORRELATIONS AMONG THE PROCESS MEASURES FOR PNEUMONIA

Process Measure 1	Process Measure 2	Correlation Between Process Measures 1 and 2
MD initial	MD day 3	0.39
RN initial	RN day 3	0.30
MD initial	RN initial	0.16
MD day 3	RN day 3	0.06
MD initial	Cultures	0.22
MD initial	Laboratory studies	0.23
Laboratory studies	Cultures	0.17
RN initial	Cultures	0.07
RN initial	Laboratory studies	0.07
MD initial	Time to first antibiotic	0.08
RN initial	Time to first antibiotic	0.05

respectively). MD cognitive assessment has low intercorrelations with RN assessment on day 1 (0.16) and on day 3 (0.06). Since the physician orders cultures (for fever work-up) and laboratory studies, we would expect adequate intercorrelations between MD processes and ordering laboratory studies and cultures. These do show intercorrelations (0.17–0.22) consistent with the process scales measuring similar, but not identical concepts. Clinically, the hospital-based nurse has little to do with culture and laboratory ordering. The intercorrelations (0.07) support the view that nursing process measures are assessing a different kind of process than those measuring the ordering of laboratory studies and cultures.

Interestingly, there is a very low intercorrelation between both initial MD cognitive and RN initial assessment scales and the amount of time it took for patients to receive their first antibiotic dose. Though from a clinical view we might expect these to correlate, they do not, and are best studied as separate process scales.

We used these principles to develop a series of process scales that are in Tables C.52 through C.55.

Table C.52

PERFORMANCE ON INITIAL PROCESS SCALES FOR 5 DISEASES

(Pre- and Post-PPS Sample Combined)

	Mean % Actual/Applicable Points				
Initial Process Scales	CHF (n=2824)	AMI (n=2853)	PNE (n=2749)	CVA (n=2824)	HIP (n=2762)
MD Cognitive Assessment	74	79	64	77	80
RN Assessment	82	81	78	67	84
Chest X-ray and EKG	92	92	88	82	92
Labs	87	83	85	86	88
ICU & Telemetry	60	86	22	39	--
Medications & Special Procedures					
O2/intubation	--	--	87	--	--
O2/intubation, digitalis	94	--	--	--	--
Medications for shock, CHF, arrthythmics, chest pain	--	65	--	--	--
Swan-Ganz catheter	--	35	--	--	--
Pacemaker	--	66	--	--	--
Streptokinase	--	52	--	--	--
Cultures	--	--	67	--	--
Antibiotics	--	--	59	--	--
Diagnostic Tests with coma	--	--	--	47	--
Overall Initial Process	82	82	69	76	85

Table C.53

PERFORMANCE ON DAY 3 PROCESS SCALES
(Pre and Post PPS sample combined)

	Mean % Actual/Applicable Points			
Day 3 Process Scales	CHF (n=2725)	AMI (n=2545)	PNE (n=2646)	CVA (n=2679)
MD Cognitive Assessment	57	66	43	67
RN Assessment	88	81	78	65
Chest X-ray and EKG	37	77	54	--
Labs	50	54	42	47
ICU and Telemetry	61	88	33	40
Use of Medications	92	64	92	--
Overall Day 3 Process	73	76	51	64

COMBINING PROCESS POINTS FOR PROCESS SCALE SCORES

For each patient, we summed the assigned and applicable points for all process criteria. If a process criterion was not applicable, we added zero to the sum of assigned points and zero to the sum of applicable points. If a criterion was applicable but was not met, we added zero to the sum of assigned points and we added the full number of applicable points to the sum of applicable points. In this latter instance, the sum of assigned points and the sum of applicable points include a measure of poor process.

Next we determined the ratio of the sum of assigned points to the sum of applicable points for each patient. We used a mean of the ratios for all patients to combine process data across patients. These means are referred to as "mean percent of assigned/applicable points."

For example, consider the process criteria for monitoring with an ICU described in Table C.8. Assume that the patient is not very sick on day 1 or day 2. The ICU is not applicable for this patient. We score this patient zero assigned points and zero applicable points for each day. Since the patient has no applicable points for ICU, we do not include this patient in the summary measure combining data across patients (i.e., the mean percent of assigned/applicable points) for the ICU.

Alternatively, assume this patient was very sick on day 1 and day 2, but was only in the ICU on day 2 and had no monitoring with ICU or telemetry on day 1. We score this patient 7 assigned and 7 applicable points on day 2, and zero assigned and 7 applicable points on day 1. The ratio of assigned/applicable points for ICU for this patient would be 7/14 or 0.5. We include this patient's ratio of 0.5 in the "mean percent of assigned/applicable points."

If the patient was very sick on day 1 and not very sick on day 2 and had no monitoring by ICU or telemetry on either day, we score this patient zero assigned and 7 applicable points on day 1 and zero assigned and zero applicable points on day 2. The ratio of assigned/applicable

Table C.54

PERFORMANCE ON INITIAL PROCESS SCALES FOR 5 DISEASES

(Pre- and Post-PPS Combined)

	Mean % Actual/Applicable Points									
	CHF		AMI		PNE		CVA		HIP	
Initial Process Scales	Pre n=1359	Post n=1465	Pre n=1416	Post n=1437	Pre n=1341	Post n=1408	Pre n=1382	Post n=1442	Pre n=1358	Post n=1404
MD Cognitive Assessment	71	76	77	80	62	66	75	79	78	81
RN Assessment	79	85	79	84	73	82	62	71	82	86
Chest x-ray and EKG	90	93	92	93	88	87	81	82	91	93
Labs	85	90	80	86	83	87	82	89	86	90
ICU & Telemetry	54	64	85	87	20	24	36	41	--	--
Medications & Special Procedures										
02/intubation	--	--	--	--	84	89	--	--	--	--
02/intubation, digitalis	93	93	--	--	--	--	--	--	--	--
Medications for shock, CHF, arrthythmics, chest pain	--	--	62	68	--	--	--	--	--	--
Swan-Ganz catheter	--	--	31	38	--	--	--	--	--	--
Pacemaker	--	--	57	74	--	--	--	--	--	--
Streptokinase	--	--	21	57	--	--	--	--	--	--
Cultures	--	--	--	--	64	70	--	--	--	--
Antibiotics	--	--	--	--	57	61	--	--	--	--
Diagnostic Tests with coma	--	--	--	--	--	--	34	60	--	--
Overall Initial Process	79	84	80	84	67	72	73	79	83	86

Table C.55

PERFORMANCE ON DAY 3 PROCESS SCALES (PRE + POST)

	Mean % Actual/Applicable Points							
	CHF		AMI		PNE		CVA	
Day 3 Process Scales	Pre n=1308	Post n=1417	Pre n=1269	Post n=1276	Pre n=1295	Post n=1351	Pre n=1302	Post n=1377
MD Cognitive Assessment	52	61	62	70	40	46	63	72
RN Assessment	85	91	80	82	72	83	59	70
Chest X-ray and EKG	44	30	78	76	51	56	--	--
Labs	43	56	55	54	42	43	50	46
ICU and Telemetry	61	61	88	88	33	34	40	41
Use of Medications	91	92	64	64	93	90	--	--
Overall Day 3 Process	71	76	75	77	47	55	60	68

points for ICU for this patient would be 0/7 or 0. We do include this patient's ratio in the "mean percent of assigned/applicable points."

PERFORMANCE ON PROCESS SCALES

We used the principles of scale development and the process measures described previously to develop six initial process scales measuring process on the first two hospital days (Table C.52 for the pre- and post-PPS sample combined). Table C.53 shows six scales and an overall scale measuring day 3 process for the pre- and post-PPS sample combined as a proxy for subsequent hospital days. Table C.54 compares performance on initial process scales for the pre- versus post-PPS sample. Table C.55 compares performance on day 3 process scales for pre- versus post-PPS sample.

Appendix D

FURTHER DETAILS ON MEASURING INSTABILITY AT DISCHARGE

Tables D.1 through D.5 show the regressions of instability at discharge (a dichotomous variable) on overall process of care and sickness at admission for each disease. The sample excludes patients with inhospital death, do not resuscitate orders, or transfers to acute care hospitals.

Tables D.6 through D.9 show regressions as in Tables D.1 through D.5. However, in Tables D.6 through D.7, the sample excludes patients with a preadmission residence of nursing home, in addition to the exclusions noted in Tables D.1 through D.5.

Table D.10 shows the percentage of patients with measures of instability present at discharge in the pre- compared with the post-PPS period. The study sample excludes inhospital deaths, transfers to acute care hospitals, and patients with "do not resuscitate" orders written ever during the hospital stay.

Table D.11 shows the percentage of patients with measures of sickness at discharge in the pre- compared with the post-PPS period. The study sample excludes inhospital deaths, transfers to acute care hospitals, and patients with "do not resuscitate" orders written ever during the hospital stay.

Table D.1

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH CONGESTIVE HEART FAILURE FOR SAMPLE PATIENTS

```
  Source |       SS         df       MS              Number of obs =    2342(4)
---------+------------------------------             F(  3,  2338) =    3.89
   Model |  2.62210975      3  .874036583            Prob > F      =  0.0088
Residual |  525.160982   2338  .224619753            R-square      =  0.0050
---------+------------------------------             Adj R-square  =  0.0037
   Total |  527.783091   2341  .225451983            Root MSE      =  .47394

Variable | Coefficient    Std. Error       t     Prob > |t|        Mean
---------+-------------------------------------------------------------------
 dinstab |                                                       .1827498
---------+-------------------------------------------------------------------
process(1|)  -.0252842      .0105609    -2.394     0.017        .0641805
  sev30(2|)   .0062882      .0031051     2.025     0.043        31.00482
 sev180(3|)  -.0027089      .0021021    -1.289     0.198        36.28997
   _cons |    .0877145      .0434954     2.017     0.044               1
---------+-------------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.
(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.
(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.
(4) Includes patients admitted from home or from a nursing home.

Table D.2

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH ACUTE MYOCARDIAL INFARCTION FOR SAMPLE PATIENTS

```
  Source |      SS          df        MS               Number of obs =    1946(4)
---------+------------------------------               F(  3,  1942) =    1.90
   Model |  .589727516      3  .196575839              Prob > F      =  0.1250
Residual |  200.467313   1942  .103227246              R-square      =  0.0029
---------+------------------------------               Adj R-square  =  0.0014
   Total |   201.05704   1945  .103371229              Root MSE      =  .32129

Variable | Coefficient    Std. Error       t     Prob > |t|         Mean
---------+---------------------------------------------------------------
 dinstab |                                                       .1012333
---------+---------------------------------------------------------------
process(1)|   -.0127985          .0082    -1.561     0.119        .1061341
  sev30(2)|   -.0013617       .0015676    -0.869     0.385        21.45644
 sev180(3)|   -.0000462         .00108    -0.043     0.966        34.65304
   _cons |    .1334108       .0191714     6.959     0.000               1
---------+---------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.

(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.

(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.

(4) Includes patients admitted from home or from a nursing home.

Table D.3

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH PNEUMONIA FOR SAMPLE PATIENTS

```
  Source |       SS         df       MS            Number of obs =    2143(4)
---------+------------------------------           F(  3,  2139) =    9.25
   Model |  4.82600703      3  1.60866901           Prob > F      =  0.0000
Residual |   371.86368   2139  .173849313           R-square      =  0.0128
---------+------------------------------           Adj R-square  =  0.0114
   Total |  376.689687   2142  .175858864           Root MSE      =  .41695

Variable |  Coefficient    Std. Error       t    Prob > |t|         Mean
---------+---------------------------------------------------------------
 dinstab |                                                     .1577228
---------+---------------------------------------------------------------
 process(1|)   -.0059021       .009281    -0.636     0.525        .014871
   sev30(2|)    .0015728        .00236     0.666     0.505       22.55418
  sev180(3|)    .0016339      .0018999     0.860     0.390       27.97711
   _cons |    .0766255      .0179909     4.259     0.000              1
---------+---------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.
(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.
(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.
(4) Includes patients admitted from home or from a nursing home.

Table D.4

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH CEREBROVASCULAR ACCIDENT FOR SAMPLE PATIENTS

```
  Source |       SS          df         MS              Number of obs =    1927(4)
---------+------------------------------               F(  3,   1923) =   12.29
   Model |  8.55950834        3  2.85316945            Prob > F       =  0.0000
Residual |  446.585276     1923  .232233633            R-square       =  0.0188
---------+------------------------------               Adj R-square   =  0.0173
   Total |  455.144785     1926  .236316088            Root MSE       =  .48191

Variable | Coefficient     Std. Error        t     Prob > |t|         Mean
---------+---------------------------------------------------------------------
 dinstab |                                                         .2376751
---------+---------------------------------------------------------------------
 process(1)   -.0312874       .0118497      -2.640      0.008       .0352452
   sev30(2)   -.0008482       .0028251      -0.300      0.764       14.90474
  sev180(3)    .0057283       .0022188       2.582      0.010       23.58632
   _cons |     .116309        .0254959       4.562      0.000              1
---------+---------------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.
(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.
(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.
(4) Includes patients admitted from home or from a nursing home.

Table D.5

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH HIP FRACTURE FOR SAMPLE PATIENTS

```
  Source |      SS          df        MS            Number of obs =    2551(4)
---------+------------------------------            F(  3,  2547) =   21.70
   Model | 15.3375361      3  5.11251204            Prob > F      =  0.0000
Residual | 600.179516   2547  .235641742            R-square      =  0.0249
---------+------------------------------            Adj R-square  =  0.0238
   Total | 615.517052   2550  .241379236            Root MSE      =  .48543

Variable | Coefficient    Std. Error       t     Prob > |t|         Mean
---------+---------------------------------------------------------------
 dinstab |                                                       .2371619
---------+---------------------------------------------------------------
process(1)   -.0027941      .0095015     -0.294      0.769      -.0033951
   sev30(2)   .0020803      .0030464      0.683      0.495       6.998122
  sev180(3)   .0069131      .0014888      4.643      0.000       14.24408
   _cons |    .1241237      .0174399      7.117      0.000              1
---------+---------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.
(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.
(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.
(4) Includes patients admitted from home or from a nursing home.

Table D.6

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH CONGESTIVE HEART FAILURE FOR PATIENTS ADMITTED FROM HOME

```
  Source |       SS          df        MS            Number of obs =    2008(4)
---------+------------------------------             F(  3,  2004) =    5.30
   Model |  3.48699844      3  1.16233281            Prob > F      =  0.0014
Residual |  439.580731   2004  .219351662            R-square      =  0.0079
---------+------------------------------             Adj R-square  =  0.0064
   Total |  443.067729   2007    .2207612            Root MSE      =  .46835

Variable | Coefficient    Std. Error       t     Prob > |t|          Mean
---------+-------------------------------------------------------------------
 dinstab |                                                       .1713147
---------+-------------------------------------------------------------------
process(1)   -.0314093       .0116404    -2.698      0.007        .1144944
  sev30(2)    .0090492       .0033602     2.693      0.007        30.65672
 sev180(3)   -.0044498       .0022858    -1.947      0.052        35.53591
   _cons |    .0556204       .0474292     1.173      0.241               1
---------+-------------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.

(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.

(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.

(4) Includes patients admitted from home or from a nursing home.

Table D.7

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH ACUTE MYOCARDIAL INFARCTION FOR PATIENTS ADMITTED FROM HOME

```
  Source |       SS         df       MS            Number of obs =    1737(4)
---------+------------------------------           F(  3,  1733) =    2.10
   Model |  .652496326      3  .217498775          Prob > F      =  0.0973
Residual |  179.901332   1733  .103809193          R-square      =  0.0036
---------+------------------------------           Adj R-square  =  0.0019
   Total |  180.553828   1736  .104005662          Root MSE      =  .32219

Variable |  Coefficient    Std. Error       t     Prob > |t|         Mean
---------+-------------------------------------------------------------------
 dinstab |                                                       .1030512
---------+-------------------------------------------------------------------
 process(1)   -.0179784       .0088459    -2.032      0.042          .14738
   sev30(2)   -.0014555       .0016814    -0.866      0.387        21.22408
  sev180(3)    .0001663       .0011754     0.141      0.888        34.05825
   _cons |     .1309308          .0203     6.450      0.000               1
---------+-------------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.
(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.
(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.
(4) Includes patients admitted from home or from a nursing home.

Table D.8

REGRESSION OF INSTABILITY AT DISCHARGE ON PROCESS AND SICKNESS AT ADMISSION FOR PATIENTS WITH PNEUMONIA FOR PATIENTS ADMITTED FROM HOME

```
  Source |       SS         df        MS            Number of obs =    1623(4)
---------+-----------------------------            F(  3,  1619) =    6.57
   Model |  3.31009859      3   1.1033662           Prob > F      =  0.0003
Residual |   272.09594   1619    .1680642           R-square      =  0.0120
---------+-----------------------------            Adj R-square  =  0.0102
   Total |  275.406038   1622  .169794105           Root MSE      =  .40996

Variable | Coefficient    Std. Error       t    Prob > |t|          Mean
---------+-----------------------------------------------------------------
 dinstab |                                                       .1417129
---------+-----------------------------------------------------------------
process(1)|   .0036878      .0108757     0.339     0.735        .1281555
  sev30(2)|   .0025611      .0028124     0.911     0.363        20.03255
 sev180(3)|    .000962      .0022616     0.425     0.671        24.69526
   _cons |    .0661784      .0198653     3.331     0.001               1
---------+-----------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.

(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.

(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.

(4) Includes patients admitted from home or from a nursing home.

Table D.9

REGRESSION OF INSTABILITY AT DISCHARGE
ON PROCESS AND SICKNESS AT ADMISSION FOR
PATIENTS WITH HIP FRACTURE
FOR PATIENTS ADMITTED FROM HOME

```
  Source |       SS         df        MS            Number of obs =    1889(4)
---------+------------------------------            F(  3,  1885) =   17.90
   Model |  12.1780955      3  4.05936517           Prob > F      =  0.0000
Residual |    427.3984   1885  .226736552           R-square      =  0.0277
---------+------------------------------            Adj R-square  =  0.0262
   Total |  439.576496   1888  .232826534           Root MSE      =  .47617

Variable | Coefficient    Std. Error       t     Prob > |t|         Mean
---------+-----------------------------------------------------------------
 dinstab |                                                        .2175754
---------+-----------------------------------------------------------------
process(1)   -.0003077      .0107957     -0.029      0.977       -.0032458
   sev30(2)   .0028907      .0038577      0.749      0.454        6.724002
  sev180(3)   .0074071      .0020696      3.579      0.000        11.61056
   _cons      .1121364      .0187481      5.981      0.000               1
---------+-----------------------------------------------------------------
```

(1) Overall process scale. See Sec IV. for details.
(2) Sev 30 is the sickness at admission scale designed to predict death within 30 days post-admission. See Sec. III for details.
(3) Sev 180 is the sickness at admission scale designed to predict death within 180 days post-admission. See Sec. III for details.
(4) Includes patients admitted from home or from a nursing home.

Table D.10

MEASURES OF INSTABILITY AT DISCHARGE FOR THE PRE- VERSUS POST-PPS SAMPLE

Measures of Discharge Instability (2)	Patients Discharged with Instability at Discharge (1) (%)											
	CHF		AMI		PNE		CVA		HIP		5 Diseases	
	Pre (n) 1122	Post (n) 1230	Pre (n) 991	Post (n) 955	Pre (n) 1073	Post (n) 1072	Pre (n) 916	Post (n) 1011	Pre (n) 1245	Post (n) 1306	Pre (n) 5341	Post (n) 5572
Fever (temp > 101 F)	0	0	0.2	1.0	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2
New incontinence	4.1	5.1	-	-	5.5	6.1	13.6	17.5 *	11.1	13.5	8.5	10.4 *
New chest pain	1.7	1.1	0.3	0.2	1.1	1.4	-	-	1.9	3.6 *	1.3	1.7
New shortness of breath	1.3	1.8	0.9	1.4	1.1	1.8	1.1	1.8	-(3)	-(3)	1.1	1.7 *
New confusion	3.7	5.4	2.3	3.4	2.0	3.0	-	-	4.8	6.1	3.3	4.6 *
New heart rate >= 130	0.3	1.1 *	0.1	0.2	0.2	0.8	0.1	0.6	0	0.3 *	0.1	0.6 *
New respiratory rate >= 130	1.2	2.5 *	0.7	0.7	1.6	2.1	2.1	1.5	1.2	1.8	1.3	1.8
Diastolic BP > 105	1.2	1.8	0.6	0.4	1.1	1.0	2.5	3.2	0.8	0.5	1.2	1.3
New systolic BP < 90	2.1	2.5	1.9	1.3	0.8	1.7 *	1.3	1.5	0.7	0.7	1.3	1.4
New heart rate < 50	-	-	1.2	2.5 *	-	-	-	-	-	-	1.2	2.5 *
New PVC	-	-	0.7	1.2	-	-	-	-	-	-	0.7	1.1 *
>= 1 Instability	13.5	17.2 *	8.5	10.6	12.6	16.0 *	6.6	22.6	18.8	23.1 *	14.6	18.3 *
Mean # of Instabilities	0.15	0.21*	0.09	0.11	0.14	0.18	0.07	0.27	0.21	0.27	0.16	0.21 *

(1) Excludes inhospital deaths and transfers to acute care hospitals.

(2) All measures of discharge instability and sickness evaluate the presence of symptoms and/or signs on the day prior to discharge and/or the day of discharge.

(3) For hip fracture chest pain is defined as chest pain or shortness of breath

* $p < 0.05$

Table D.11

MEASURES OF SICKNESS AT DISCHARGE FOR THE PRE- VERSUS POST-PPS SAMPLE

Measures of Discharge Sickness (2)	Patients Discharged with Sickness at Discharge (1) (%)											
	CHF		AMI		PNE		CVA		HIP		5 Diseases	
	Pre (n) 1122	Post (n) 1230	Pre (n) 991	Post (n) 955	Pre (n) 1073	Post (n) 1072	Pre (n) 916	Post (n) 1011	Pre (n) 1245	Post (n) 1306	Pre (n) 5341	Post (n) 5572
Fever (temp > 101 F)	0	0	0.2	0.1	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.1
New incontinence	4.1	5.1	-	-	5.5	6.1	13.6	17.5 *	11.1	13.5	8.9	10.4 *
Chest pain	5.1	5.8	7.8	8.9	4.6	5.0	-	-	2.2	4.3 *	5.7	5.8 *
Shortness of breath	24.5	33.7 *	6.6	9.0 *	10.7	20.8 *	2.5	4.5 *	-(3)	-(3)	11.7	18.1 *
Confusion	11.3	15.1 *	7.0	8.2	8.9	13.3 *	-	-	9.0	11.6 *	9.1	12.2 *
Heart rate >= 130	0.5	1.8 *	0.3	0.5	0.4	1.2 *	0.2	0.6	0	0.3 *	0.3	0.9 *
Respiratory rate >= 30	4.1	6.7 *	1.3	1.4	6.7	10.2 *	3.7	3.0	2.2	2.5	3.6	4.8 *
Diastolic BP > 105	1.2	1.8	0.6	0.4	1.1	1.0	2.5	3.2	0.8	0.5	1.2	1.4
New systolic BP < 90	4.3	4.4	3.7	3.4	1.5	2.3	1.4	1.8	1.0	0.8	2.4	2.5
New decubitus	1.5	1.0	-	-	2.1	2.1	0	0	9.7	7.4 *	4.3	3.3 *
Heart rate < 50	-	-	3.2	5.0 *	-	-	-	-	-	-	3.2	5.0 *
PVC	-	-	1.4	3.3 *	-	-	-	-	-	-	1.4	3.3 *
Parenteral antibiotics					23.3	48.9 *					23.4	48.8 *
>= 1 Sickness	42.2	52.7 *	26.6	32.3 *	47.9	72.8 *	22.6	27.6 *	29.0	32.5	34.0	43.7 *
Mean # of Sicknesses	0.57	0.75*	0.32	0.40*	0.65	1.11*	0.27	0.33*	0.36	0.41*	0.44	0.60*

(1) Excludes inhospital deaths and transfers to acute care hospitals.
(2) All measures of discharge instability and sickness evaluate the presence of symptoms and/or signs on the day prior to discharge and/or the day of discharge.
(3) For hip fracture chest pain is defined as chest pain or shortness of breath

* $p < 0.05$

Appendix E

METHODS FOR STUDYING OUTCOMES SUBSEQUENT TO ACUTE CARE HOSPITAL DISCHARGE

POSTDISCHARGE MORTALITY: DATA CLEANING

To study the effect of DRG-based prospective payment on outcomes, we have supplemented the study of inhospital outcomes with the study of postdischarge death, readmissions, and duration of stay in a nursing home.

Using the Medical Record as a Data Base

We began the process of accessing the data by collecting data from the medical record of all cases abstracted regardless of whether the case was ultimately included in or excluded from the study sample. From each medical record we sought the Health Insurance Claim (HIC) number (consisting of a nine digit Social Security number and a three digit Beneficiary Insurance Claim (BIC) number). If no HIC number was available from the medical record, we supplied the Social Security number (SSN); this was done for 5 percent of the cases. The data generated from the medical record are known as the RAND file.

Using HCFA Files as the Data Base

We used existing HCFA files as the source for postdischarge mortality and readmission data. The HCFA file provided patients' Health Insurance Claim (HIC) numbers, last and first names, and dates of birth. The goal of this effort was to match HIC numbers between the RAND-generated file (based upon medical record data) and the HCFA files. HCFA used the Health Insurance Master File (also known as HIM or HIPO) to provide mortality data and the Bill Retrieval File to provide readmission data.

Matching the RAND Medical Record File and the HCFA Files

Matching files by HIC number will have limited success in accessing valid mortality data if the HIC number elicited from the medical record (or recorded in the RAND file) is missing or inaccurate. To determine the number of cases that could be accurately matched between the RAND and HCFA files, we developed an extensive data cleaning process. Table E.1 diagrams the method in which the data were received and cleaned. Initially, we submitted the RAND file with data for 19,540 patients (included and excluded abstraction forms) to HCFA. This number was 88 percent of the total number of cases eventually submitted to HCFA. We submitted only 88 percent of cases at this time because fieldwork was incomplete.

Matching was done by HCFA; they compared RAND and HCFA HIC numbers. HCFA returned to RAND more records than we sent (n = 19,595), since HCFA provided some duplicate matches for cases that had missing BICs. We were able to use HCFA's Health Insurance Master File to find mortality information for 87.2 percent of the cases. The remaining 12.8 percent of cases (n = 2,514) could be categorized as follows: no match because

Table E.1

MATCHING THE RAND MEDICAL RECORD FILE AND THE HCFA FILES

```
                           19,540 Include & exclude records sent to HCFA
                             |
                           19,595 Records received from HCFA
                             |
            -----------------------------------------------------
          17,081                                                2514
         (87.2%)                                             (12.8%)
    HIC number match                                         No match
           |                                                    |
 ----------------------------------------------------           |
12,218                     3639                    1224          |
(62.4%)                  (18.6%)                 (6.2%)         |
correct match on       Questionable            Incorrect        |
last name, first       names, dob              names, dob       |
name, date of birth        |                        |           |
             |             |                        |           |
             |             --------------------------------------
             |                          Sent to HCFA to obtain
             |                          corrected HIC numbers by
             |                        matching on last & first name
             |
             |                             |
             |                             |
          9,465                         7,170
          Include records               Include records only.
          only                          File recieved from
             |                          HCFA after matching
             |                          using corrected HIC numbers
             |    16,635                           |
             |    Include records                  |
             |    received from HCFA after         |
             |--- matching by HIC number and------|
                   corrected HIC number
                           |
          |--------------------------------------------|
          |              |              |              |
     15,413             34            932            256
      92.65%          0.29%          5.60%          1.54%
     Correctly          Correctly     Questionable   Incorrectly
     matched on         matched on    patients       matched on
     last name,         last name,                   last name,
     first name, &      first name, &                first name, &
     date of birth.     date of birth,               date of birth
     Includes hand      but no mortal-
     check              ity information
          |
          |                                    16,766
          |                                    Include patients
          |                                    in our dataset
          |                                         |
          |-----------------------------------------|
                   |                       |
              15,381                   1,399
               92.00%                   8.00%
               Match with               No match with
               RAND dataset             RAND dataset
```

the patient's medical record (and so the RAND file) had a Railroad Board number instead of a HIC number (2.1 percent, n = 402); no match because of an invalid HIC number (4.8 percent, n = 934); no match because neither HIC number nor SSN appeared on the medical record (2.7 percent, n = 523); and finally, HIC number was identified as no longer current, but a cross reference number was provided that could be used in subsequent searches (3.4 percent, n = 655).

For patients who had a HIC number match (87.2 percent), RAND verified that the information provided on the file actually corresponded to RAND's study patients. The verification was necessary, since it was possible for a HIC number to be valid but not belong to a study patient. This was a problem particularly when the patient was not the primary wage earner, and thus used his or her spouse's Social Security number. To verify the accuracy of the HIC numbers of the 87.2 percent of patients, we compared first name, last name, and date of birth between the RAND medical record data and the data obtained from the HIM (HIPO) file.

Roughly 62 percent of the cases received from HCFA matched exactly on all three variables and were considered "correct." An additional 19 percent matched on one or two variables, and were classified as "questionable." The remaining 6 percent did not match on first name, last name, or date of birth, and were considered "incorrect." Because these last two categories plus the 12.9 percent with no matches constituted over one-third of the data, we used another source to check the validity of the HIC numbers for the cases without exact matches.

We supplemented the HIC number matches with a second analysis of HCFA files. The purpose of this second analysis was to match RAND patients with HCFA patients using last and first names. This allowed us to verify HIC numbers and to correct HIC numbers for name matches if the HIC number deviated slightly. The newly corrected HIC numbers were forwarded again to HCFA for a final run through the Health Insurance Master File and the Bill Retrieval File.

We used one other method for accessing HIC numbers. When the medical record provided no data about HIC numbers, we worked with state-specific insurance carriers to access those data. They were able to provide HIC numbers for roughly 60–70 percent of patients whose medical record provided no data about HIC numbers. These HIC numbers were also submitted to HCFA to be run through the Health Insurance Master File and Bill Retrieval File.

A check for accuracy was performed on this file, which included a "hand check" of records that did not match exactly on all three of the variables listed above. Variables are considered correctly matched if there are obvious misspellings or transpositions. In general, if at least two of the three variables matched, whether by exact match or "hand check," the record was considered correct.

Based on an exact match, 70 percent of the included records were correct. The remainder of the cases were considered questionable. Using the rules listed in Table E.2, another 22 percent of the records were considered correct by the "hand check" criteria.

The most frequent source of patient mismatch (last name, first name, date of birth) when HIC numbers matched between RAND and HCFA files was matching error, because patients used spouses' HIC numbers. This was a problem for up to 1.2 percent of the included cases. All other matching errors combined made up fewer than 1 percent. HCFA was unable to match HMO patients as well as undocumented patients who still had unclean HIC numbers, and subsequently, 4.3 percent of the included cases were not matched. In summary, for patients on whom we had HIC numbers on both the RAND and HCFA file, we

Table E.2

CRITERIA FOR DECIDING WHETHER QUESTIONABLES ARE CORRECT

	Last Name	First Name	Date of Birth	Keep if:
1.	-	-	+	a. First and last names reversed.
				b. First and last names obviously correct but misspelled.
2.	-	+	+	a. Last names obviously correct but misspelled.
				b. Different last names and female first names since these are probably women using their maiden names.
3.	-	+	-	a. Last names obviously correct but misspelled or patient is female (using maiden name) and date of birth not off by more than 5 years.
				b. Last names obviously correct but misspelled or patient is female (using maiden name) and month, day, or year of birth interchanged.
4.	+	-	+	a. First names obviously correct but misspelled.
				b. HCFA first initials match the first character of RAND first names.
				c. First name and middle name reversed.
5.	+	-	-	a. First names obviously correct but misspelled and date of birth not off by more than 5 years.
				b. First names obviously correct but misspelled and month, day, or year of birth interchanged.
				c. HCFA first initials match the first character of RAND first names and date of birth not off by more than 5 years.
				d. HCFA first initials match the first character of RAND first names and month, day, or year of birth interchanged.
				--> Incorrect individuals in this category were usually wives using their husband's HIC numbers.
6.	+	+	-	a. All considered correct.

found 92.65 percent of patients had an acceptable match on last name, first name, and date of birth. This file is 92.65 percent correct. (The figure of 62 percent cited earlier was relevant to both included and excluded sample patients and the 92.65 percent is relevant to included sample patients only. A more thorough verification check was used for the included sample.)

The next step was to link the 92.65 percent (n = 15,413) patients for whom we had clean mortality information with the HCFA databases. We were able to obtain a match on 92 percent of the cases. The remaining 8 percent consist of patients for whom HCFA was unable to match for reasons specified above. Table E.3 presents the pre/post PPS breakdown of the 8 percent who do not match.

A higher proportion of pre-PPS (61.3 percent) than post-PPS (38.7 percent) patients did not match. This may be due to data abstracting errors. Records that are six years old are more faded and therefore harder to read than records that are two years old. This increases the likelihood that a HIC number will be misread and subsequently cause a nonmatching record.

Nonmatching patients who died inhospital are similarly distributed with 62.9 percent pre-, and 37.1 percent post-PPS (Table E.4). Since inhospital death does not differ with study period for patients who died inhospital compared with all nonmatching patients, inhospital deaths were not disproportionately represented among the nonmatching patients. We found that patients with inaccurate data who died inhospital are distributed similarly across time periods: 20 percent pre-PPS compared with 19 percent post-PPS ($p \geq 0.05$).

Table E.3

ABSTRACT FORM INCLUDES CASES WITHOUT ADEQUATE MATCH IN POSTDISCHARGE FILE BY STUDY PERIOD

Period	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Pre	858	61.3	858	61.3
Post	541	38.7	1399	100.0

Table E.4

ABSTRACT FORM INCLUDES CASES WITHOUT ADEQUATE MATCH IN POSTDISCHARGE FILE BY STUDY PERIOD: IN-HOSPITAL DEATHS ONLY

Period	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Pre	173	62.9	173	62.9
Post	102	37.1	275	100.0

We studied this further by evaluating the accuracy of the date of death as reported in both HCFA's HIM file and the RAND medical record file. Table E.5 shows the percentage of cases with agreement in date of death for each of the study years. Table E.6 shows the percentage of cases with agreement in date of death for the pre-PPS versus post-PPS periods. Both Tables E.5 and E.6 show a very high fraction of cases (> 94 percent) with agreement in date of death between the two data files.

For the purpose of analysis, patients who died after March 23, 1988, were censored at that date. This was the date that the initial postdischarge mortality file was received, and since only incorrect records were sent back to HCFA to be cleaned, mortality information on correct records was not available after this date. Another correction was made if the patient died inhospital and the postdischarge mortality date was different from the discharge date: Then, the date of death was taken as the hospital discharge date, because there is sometimes a lag in reporting death dates, and hospital discharge dates were considered more accurate.

Table E.5

VERIFICATION OF DATE OF INHOSPITAL DEATH BY RAND AND HCFA DATA SETS BY STUDY YEAR (1)

	Study Year			
Dates of Inhospital Death Agree Within:	1981 (n=362)	1982 (n=537)	1985/86 (n=851)	Total (n=1750)
1 Day	19.4	28.6	45.8	93.8
> 1 day - < 1 week	0.6	0.9	1.1	2.6
> 2 weeks - 3 weeks	0.3	0.3	0.7	1.3
> 3 weeks - 4 weeks	0.2	0.3	0.3	0.9
> 4 weeks	0.1	0.2	0.4	0.7
> 2 - 3 months	0.0	0.2	0.2	0.4
> 3 - 4 months	0.0	0.0	0.1	0.1
3 - 4 months	0.0	0.1	0.0	0.1
> 4 months	0.2	0.1	0.0	0.2
Total	20.7	30.7	48.6	100.0

(1) This appendix includes only sample patients included in the final study sample who also had an adequate match between RAND and HCFA files who also died inhospital.

A final correction was made for the Record Identification Code (RIC) = C (cross reference) patients. Mortality dates for these patients are actually the dates the HIC numbers were changed. These patients were included only if this date was later than their discharge date and were censored as of that date.

ADJUSTING DISCHARGE DESTINATION FOR SICKNESS AT ADMISSION

Just as comparisons of rates of mortality pre- and post-PPS need to be adjusted for sickness at admission, comparisons of rates of discharge to home or nursing home also need to be adjusted for sickness at admission. To accomplish this, we used methods similar to those used to develop the measures designed to predict death (see Sec. III). We began with the same variables used in the development of the death scales. Each variable was scored by physicians using clinical judgment about whether the variable was likely to predict discharge

Table E.6

VERIFICATION OF DATE OF INHOSPITAL DEATH
BY RAND AND HCFA DATA SETS
BY PPS PERIOD (1)

	Study Period		
Dates of Inhospital Death Agree Within:	Pre-PPS (n=899)	Post-PPS (n=851)	Total (n=1750)
1 day	48.0	45.8	93.8
> 1 day - < 1 week	1.5	1.1	2.6
> 2 weeks - 3 weeks	0.6	0.7	1.3
> 3 weeks - 4 weeks	0.5	0.3	0.9
> 4 weeks	0.3	0.4	0.7
> 2 - 3 months	0.2	0.2	0.4
> 3 - 4 months	0.0	0.1	0.1
3 - 4 months	0.1	0.0	0.1
> 4 months	0.2	0.0	0.2
Total	30.7	48.6	100.0

(1) This appendix includes only sample patients included in the final study sample who also had an adequate match between RAND and HCFA files who also died inhospital.

to home or a nursing home. If clinicians believed the variable was likely to predict discharge to a nursing home (score > 0 using a 0–4 rating system) and if the variable was not already included in the disease-specific scale designed to predict death, then the variable was eligible for inclusion in the scale to predict discharge to a home (rather than an institution). We used logistic regression of discharge to home on both the scale to predict death (Sec. III), and the other variables rated by clinicians to predict discharge to home (rather than an institution), to develop the scale to predict discharge to home. Table E.7 shows this regression for patients with cerebrovascular accident as an example of the methods used. Table E.8 shows rates of discharge to nursing homes with and without adjustment for sickness at admission using the scales described above for cerebrovascular accident patients.

COMPARING OUTCOMES BEFORE AND AFTER PPS IMPLEMENTATION

Table E.9 presents data for mean length of stay pre- and post-PPS after adjustment for sickness at admission. These adjusted length-of-stay values do not differ substantially from the unadjusted values. (See unadjusted length of stay values presented in Table 7.1.)

Table E.10 presents mortality rates pre- and post-PPS implementation without adjustment for sickness at admission. Inhospital mortality is 2.3 percentage points lower post-PPS ($p < 0.01$), and mortality within 30 days postadmission is 16.0 percent in both time periods. Mortality rates within six months postadmission were somewhat but insignificantly higher post-PPS (28.9 percent pre-PPS and 29.8 percent post-PPS). (See adjusted mortality values presented in Table 7.2.)

Table E.11 presents mortality rates pre- and post-PPS implementation with adjustment for sickness at admission. The t-values comparing mortality rates for the two time periods are listed.

Table E.12 shows the frequency with which patients with a preadmission residence of home or nursing home have various discharge destinations in the pre- and post-PPS periods unadjusted for sickness at admission. Fewer patients with a preadmission residence of home are discharged to home in the post-PPS period (77 percent pre-PPS and 73 percent post-PPS). (See Table 7.3.)

Table E.13 shows the frequency with which patients with a preadmission residence of home or nursing home have various discharge destinations in the pre- and post-PPS periods adjusted for sickness at admission. The t-test is used for comparing pre- and post-PPS rates of distribution of patients from home to each discharge destination individually.

Table E.14 again compares discharge destinations pre- and post-PPS. However, for this appendix, the chi-square test compares the distributions of patients admitted from home to the various discharge destinations.

STUDYING PROLONGED NURSING HOME STAYS

The only available data source for studying duration of stay in a nursing home is Medicare's Part B files of physician bills. When a physician bills for a nursing home visit, either the place of service is designated as a nursing home or a special procedure code is used. We requested Medicare Part B claims data for patients from the six insurance carriers responsible for such data in the five study states. Because of the difficulty and/or experience of retrieving the pre-PPS data, we limited our work with prolonged nursing home stays to

Table E.7

PREDICTING DISCHARGE TO HOME WITH SICKNESS-AT-ADMISSION VARIABLES FOR HIP FRACTURE PATIENTS

```
                                        PGM = H_REG1.SAS
                                     INPUT = DRGI.SHIP.E4 (E4)
                                          DISCH TO HOME

MODEL: A1
DEP VARIABLE: TOHOME   DISCHARGED TO HOME
                                          ANALYSIS OF VARIANCE

                                    SUM OF         MEAN
                  SOURCE     DF    SQUARES       SQUARE       F VALUE      PROB>F

                  MODEL      12  58.11730393   4.84310866      22.097      0.0001
                  ERROR    1803    395.16904   0.21917307
                  C TOTAL  1815    453.28634

                     ROOT MSE     0.4681592      R-SQUARE      0.1282
                     DEP MEAN     0.5198238      ADJ R-SQ      0.1224
                     C.V.          90.06114

                                          PARAMETER ESTIMATES

                          PARAMETER        STANDARD      T FOR H0:                    VARIABLE
         VARIABLE  DF      ESTIMATE           ERROR    PARAMETER=0    PROB > |T|        LABEL

         INTERCEP   1    1.82759758      0.12337321         14.814        0.0001    INTERCEPT
         NEWSEV     1   -0.17772658      0.22585410         -0.787        0.4314
         AGE        1   -0.01320728     0.001465397         -9.013        0.0001    AGE IN YEARS AT ADMISSION
         ALONE      1   -0.17789219      0.02414884         -7.366        0.0001
         DEMENT     1   -0.16876693      0.03287011         -5.134        0.0001
         INCONT     1   -0.08161226      0.03880629         -2.103        0.0356
         FEMUR      1    0.06834070      0.02222163          3.075        0.0021
         NOWALK     1    0.20621835      0.10926360          1.887        0.0593
         PREVFRAC   1   0.005630587      0.03726307          0.151        0.8799
         FEMALE     1   -0.07657199      0.02763214         -2.771        0.0056    GENDER IS FEMALE (0 OR 1)
         WHITE      1   -0.10910215      0.03521533         -3.098        0.0020
         POOR       1    0.06582720      0.03078979          2.138        0.0327    POOR INDICATOR
         POST       1   -0.07041209      0.02211821         -3.183        0.0015
```

Table E.8

RATES OF DISCHARGE TO HOME PRE- AND POST-PPS FOR HIP FRACTURE PATIENTS WITH AND WITHOUT ADJUSTMENT FOR SICKNESS AT ADMISSION (1)

		Without Adjustment	With Adjustment
		Patients Discharged to Home (%)	
Disease	PPS Period		
Hip Fracture	Pre-PPS	55.7	55.7
	Post-PPS	48.3	48.7

(1) Using scales designed to predict discharge to home. The sample includes only patients with a preadmission residence of home.

Table E.9

MEAN LENGTH OF STAY

Pre- and Post-PPS(1)

Adjusted Mean LOS in Days

Disease	n	Pre-PPS	Post-PPS	Difference
CHF	2824	11.1	8.8	-2.3*
AMI	2853	12.7	10.4	-2.3*
PNE	2749	12.2	10.4	-1.7*
CVA	2824	16.2	11.1	-5.1*
HIP	2762	20.2	14.4	-5.6*
5 Diseases	14012	14.4	11.00	-3.4

* $p < 0.05$ for comparison of length of stay pre-PPS vs. post-PPS

(1) Length of stay adjustments are made using scales designed to predict death at 30 days post-admission.

We used the medical record as the data base for measuring length of stay for each patient. We considered the day of discharge from the acute care hospitalization the day the discharge summary noted as the discharge date. If the patient ended the acute care hospitalization but remained in the same hospital, ward, or bed (i.e. a "paper discharge") to receive other services (e.g. rehabilitation or skilled nursing care), we considered the day of discharge the day of termination of the acute hospital stay.

Table E.10

UNADJUSTED MORTALITY RATES (%)

Mortality Adjusted for Sickness at Admission	CHF		AMI		PNE		CVA		HIP		5 Diseases	
	Pre- PPS	Post- PPS	Pre- PPS	Post- PPS	Pre- PPS	Post- PPS	Pre- PPS	Post- PPS	Pre- PPS	Post- PPS	Pre- PPS	Post- PPS
	n 1359	n 1465	n 1416	n 1437	n 1341	n 1408	n 1382	n 1442	n 1358	n 1404	n 6856	n 7156
Inhospital Mortality	12.1	9.0**	23.4	22.3	14.2	13.7	22.8	17.6**	5.2	3.6*	15.6	13.3**
30-day Post-Admission Mortality	14.9	13.1	23.5	24.8	14.8	17.1	21.3	19.9	5.0	4.9	16.0	16.0
180-day Post-Admission Mortality	33.3	31.9	32.6	35.9	25.7	31.4**	35.4	34.2	17.3	15.3	28.9	29.8

** $p < 0.01$, * $p < 0.05$, for comparison of mortality rates pre-PPS vs. post-PPS

Table E.11

ADJUSTED MORTALITY RATES PRE- AND POST-PPS(%) (1)

Adjusted Mortality Rates

Mortality Adjusted for Sickness at Admission	CHF			AMI			PNE			CVA		
	Pre-PPS n 1359	Post-PPS n 1465	t-value	Pre-PPS n 1416	Post-PPS n 1437	t-value	Pre-PPS n 1341	Post-PPS n 1408	t-value	Pre-PPS n 1382	Post-PPS n 1442	t-value
Inhospital Mortality	12.3	8.9	-3.2**	24.2	21.6+	-1.7	15.5	12.6	-2.6*	22.4	17.8	-3.7**
30-day Post-Admission Mortality	14.7	13.0	-1.6	24.4	24.0	-0.0	15.9	15.7	-0.4	21.3	19.9	-1.1
180-day Post-Admission Mortality	33.5	31.7	-1.2	33.4	35.1	+0.7	27.8	29.4	+0.8	35.3	34.3	-0.6

Mortality Adjusted for Sickness at Admission	HIP			5 Diseases		
	Pre-PPS n 1358	Post-PPS n 1404	t-value	Pre-PPS n 6856	Post-PPS n 7156	t-value
Inhospital Mortality	5.7	3.3	-3.0**	16.1	12.8	-6.2**
30-day Post-Admission Mortality	5.1	4.5	-0.9	16.7	15.7	-1.7+
180-day Post-Admission Mortality	17.8	14.8	-2.2	29.6	29.2	-1.1

** $p < 0.01$, * $p < 0.05$, + $p = 0.06$ for comparison of mortality rates pre-PPS vs. post-PPS

(1) Inhospital and 30-day post-admission mortality rates are adjusted using scales designed to predict death at 30 days post-admission. 180-day post-admission mortality rates are adjusted using scales designed to predict death at both 30 and 180 days post-admission.

Table E.12

DISCHARGE DESTINATION FOR PATIENTS FROM 5 STATES BY DISEASE

Admitted From:	Discharged To:	Patients Discharged to each Destination (%)(1)(2)											
		CHF		AMI		PNE *		CVA		HIP *		5 DISEASES	
		Pre-PPS (n) 1007	Post-PPS (n) 1133	Pre-PPS (n) 960	Post-PPS (n) 990	Pre-PPS (n) 853	Post-PPS (n) 875	Pre-PPS (n) 922	Post-PPS (n) 1005	Pre-PPS (n) 894	Post-PPS (n) 987	Pre-PPS (n) 4636	Post-PPS (n) 4990
Home	Home	90	88	87	83	92	88	60	58	56	48	77	73
Home	Nursing Home	5	6	3	3	3	8	25	25	39	42	15	17
Home	Sheltered Housing	1	1	0	0	1	0	0	0	1	1	0	1
Home	Other	5	4	10	13	4	3	15	17	5	8	8	9

Admitted From:	Discharged To:	CHF		AMI		PNE		CVA		HIP		5 DISEASES	
		Pre-PPS (n) 82	Post-PPS (n) 99	Pre-PPS (n) 32	Post-PPS (n) 39	Pre-PPS (n) 204	Post-PPS (n) 268	Pre-PPS (n) 90	Post-PPS (n) 114	Pre-PPS (n) 301	Post-PPS (n) 263	Pre-PPS (n) 709	Post-PPS (n) 783
Nursing Home	Nursing Home	93	97	94	92	94	94	91	95	97	98	95	96

(1) Unadjusted for sickness at admission.

(2) The entries in this table represent the number of patients discharged to specified destinations/the number of patients discharged alive × 100.

* $p < 0.01$ using chi-square test for comparisons pre- and post-PPS of distributions of patients admitted from home to the discharge destination.

Table E.13

DISCHARGE DESTINATION FOR PATIENTS FROM 5 STATES BY DISEASE ADJUSTED FOR SICKNESS AT ADMISSION (1)

		Patients Discharged to each Destination (%)(2)											
		CHF		AMI *		PNE *		CVA		HIP *		5 DISEASES *	
Admitted From:	Discharged To:	Pre-PPS (n) 1007	Post-PPS (n) 1133	Pre-PPS (n) 960	Post-PPS (n) 990	Pre-PPS (n) 853	Post-PPS (n) 875	Pre-PPS (n) 922	Post-PPS (n) 1005	Pre-PPS (n) 894	Post-PPS (n) 987	Pre-PPS (n) 4636	Post-PPS (n) 4990
Home	Home	90	89	87	83 *	92	89 *	60	58	56	48 *	77	73 **
Home	Nursing Home	5	6	3	3	4	7 *	25	25	39	42	15	17
Home	Sheltered Housing	1	1	0	0	1	0	0	0	1	1	0	1
Home	Other	5	4	10	13	4	3	15	17	5	8 *	8	9

		CHF		AMI		PNE		CVA		HIP		5 DISEASES	
Admitted From:	Discharged To:	Pre-PPS (n) 82	Post-PPS (n) 99	Pre-PPS (n) 32	Post-PPS (n) 39	Pre-PPS (n) 204	Post-PPS (n) 268	Pre-PPS (n) 90	Post-PPS (n) 114	Pre-PPS (n) 301	Post-PPS (n) 263	Pre-PPS (n) 709	Post-PPS (n) 783
Nursing Home	Nursing Home	93	97	93	93	94	94	91	95	97	98	95	96

(1) Adjustments for sickness at admission are based upon scales designed to predict 30-day post admission mortality (Keeler, et al.).

(2) The entries in this table represent the number of patients discharged to specified destinations/the number of patients discharged alive × 100.

* $p < 0.05$ using t- tests for comparisons pre- and post-PPS of distributions of patients admited from home to the discharge destination of an institution.

Table E.14

USING MEDICARE PART B BILLS TO STUDY PROLONGED POST-ADMISSION NURSING HOME STAY BY DISEASE FOR PATIENTS HOME PRIOR TO ADMISSION

		Patients with MD bills submitted within months 5, 6, or 7 after admission (%)(1)							
Type of Bill(2)	State	CHF	AMI	PNE	CVA	HIP	DEP	5 Diseases	6 Diseases
		n=269	n=280	n=240	n=275	n=302	n=477	n=1366	n=1843
SN	A	3	2	4	10	9	2	6	5
SN or NH	A	5	2	6	14	12	4	8	7
*SN/NH/Home	A	33	12	26	33	45	12	30	25
Office	A	28	47	28	30	18	40	30	33
*Home or office	A	56	57	48	48	52	48	52	51
Any	A	82	75	68	74	72	73	74	74
		n=260	n=267	n=236	n=265	n=263	n=468	n=1291	n=1759
SN or NH	B	5	1	4	18	11	4	8	7
		n=260	n=269	n=259	n=250	n=271	n=428	n=1309	n=1737
SN	C	2	1	2	5	2	2	2	2
SN or NH/ Home	C	23	12	15	28	35	12	23	20
Office	C	31	44	34	33	21	45	32	36
Any	C	69	70	57	70	64	69	66	66

* $p < 0.05$

(1) The entries in this table represent (the number of patients with MD bills submitted within months 5, 6, or 7 after admission/the number of patients alive as of 7 months post-admission) x 100.

(2) Type of bill submitted within months 5, 6, or 7 post-admission.

three states. In the following pages, we present a series of tables that support our design decisions for this section of the study. In addition, we show state-specific and disease-specific data about duration of nursing home stay following acute care hospitalization.

Tables E.15 through E.17 show the fraction of patients with Medicare Part B physician bills submitted within three months after acute care hospitalization. The tables present disease-specific data, data for five study diseases (omitting depression), and data for six study diseases (including depression) for the three study states.

Table E.15 lists the data for a variety of patient types and bill types. These data combine the pre- and post-PPS samples.

Table E.16 shows the fraction of patients with any type of physician bill submitted for various patient types. This table presents data for the pre- and post-PPS samples combined.

Table E.17 shows the fraction of patients with nursing home bills by patient type. In this table nursing home bills are defined as bills from either a skilled nursing facility, skilled or other (residential) nursing home without distinction, or skilled or other nursing home or home care without distinction. These data are presented for the pre- and post-PPS sample combined.

Table E.18 shows the fraction of patients with nursing home bills for five diseases combined (omitting depression) for the pre- compared with post-PPS samples. This appendix shows that the likelihood of having Medicare bills post discharge for patients going to a nursing home pre-PPS compared with post-PPS varies by state. There is no significant difference in the availability of data in two states although data are more available post-PPS in State B.

Table E.19 shows the fraction of patients with nursing home bills for six diseases combined (including depression) for the pre- compared with post-PPS samples although data are more available post-PPS in State B.

Table E.20 shows the fraction of patients with physician bills submitted within months 5, 6, or 7 after admission by disease and across disease (excluding and then including depression patients) for the pre- and post-PPS samples combined. The data are presented for various definitions of nursing home bills.

Table E.21 shows the fraction of patients with physician bills submitted within months 5, 6, or 7 after admission by disease and across disease (excluding and then including depression patients) for the pre-PPS compared with the post-PPS periods.

Tables E.15 through E.19 show that most (> 85 percent) patients for whom we suspect bills should be submitted do have Medicare Part B bills on file.

Table E.21 shows a trend toward more patients staying in nursing homes months 5, 6, or 7 after acute hospitalization in the post-PPS period than the pre-PPS period. The pre-post difference is significant for only one of the three states studied.

Table E.15

USING MEDICARE PART B BILLS TO STUDY USE OF POST-DISCHARGE SERVICES: VALIDATING THE DATA BASE FOR 6 DISEASES BY COMPARING TYPES OF BILLS

Patient Type	Type of Bill(2)	State	Patients with MD bills submitted within 3 months after discharge (%)(1)							
			CHF	AMI	PNE	CVA	HIP	DEP	5 DISEASES (6)	6 DISEASES (7)
			n=344	n=330	n=340	n=342	n=404	n=538	n=1760	n=2298
Hospitalized	Inhospital	A	98	95	96	97	93	90	97	95
			n=30	n=18	n=68	n=75	n=181	n=33	n=372	n=405
Discharge to NH	Any	A	93	89	91	85	92	82	90	90
			n=28	n=10	n=55	n=67	n=135	n=31	n=295	n=326
Discharge to NH	Any(3)	B	71	80	82	96	86	94	86	86
			n=335	n=316	n=337	n=302	n=368	n=469	n=1658	n=2127
Hospitalized	Inhospital(4)	C	82	84	85	83	81	79	83	82
			n=20	n=11	n=48	n=66	n=127	n=25	n=272	n=297
Discharge to NH	Any(5)	C	95	91	85	80	84	92	84	85

(1) The entries in this table represent (the number of patients with MD bills submitted within 3 months after discharge/the number of patients alive as of 3 months after discharge) × 100.

(2) Type of bill submitted within 3 months post-discharge.

(3) Post period only

(4) Pre period is 4/81-12/82

(5) Pre period is 1982 only

(6) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture but not depression

(7) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture, AND depression.

Table E.16

USING MEDICARE PART B BILLS TO STUDY USE OF POST-DISCHARGE SERVICES: VALIDATING THE DATA BASE FOR 6 DISEASES BY COMPARING TYPES OF BILLS

Patient Type	Type of Bill(2)	State	Patients with MD bills submitted within 3 months after discharge (%)(1)							
			CHF	AMI	PNE	CVA	HIP	DEP	5 DISEASES (5)	6 DISEASES (6)
Discharge to NH	Any	A	93	89	91	85	92	82	90	90
Discharge to NH or Sheltered Housing	Any	A	92	86	91	85	90	82	89	88
Discharge to Home	Any	A	89	88	86	91	86	82	88	86
All	Any	A	89	88	87	89	88	82	88	87
Discharge to NH	Any(3)	B	71	80	82	96	86	94	86	86
Discharge to NH or Sheltered Housing	Any(3)	B	73	80	82	96	87	94	86	87
Discharge to Home	Any(3)	B	86	92	89	80	92	85	88	87
All	Any(3)	B	84	91	87	86	89	87	87	877
Discharge to NH	Any(4)	C	95	91	85	80	83	92	84	85
Discharge to NH or Sheltered Housing	Any(4)	C	81	94	82	80	82	88	82	83
Discharge to Home	Any(4)	C	85	86	89	81	86	85	86	86
All	Any(4)	C	85	86	88	81	84	85	85	85

(1) The entries in this table represent (the number of patients with MD bills submitted within 3 months after discharge/the number of patients alive as of 3 months after discharge) x 100.
(2) Type of bill submitted within 3 months post-discharge.
(3) Post period only
(4) Pre period is 1982 only
(5) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture but not depression
(6) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture, AND depression.

Table E.17

Using Medicare Part B Bills to Study Use of Post-Discharge Services: Validating the Data Base for 6 Diseases by Comparing Nursing Home or Home Bills

			Patients with MD bills submitted within 3 months after discharge (%)(1)							
Patient Type	Type of Bill(2)	State	CHF	AMI	PNE	CVA	HIP	DEP	5 DISEASES(4)	6 DISEASES(5)
			n=30	n=18	n=68	n=75	n=181	n=33	n=372	n=405
Discharge to NH	SN	A	50	78	68	61	62	42	63	61
Discharge to NH	SN or NH	A	83	83	78	71	74	61	75	74
			n=38	n=21	n=80	n=82	n=198	n=62	n=419	n=481
Discharge to NH or Sheltered Housing	SN or NH	A	76	71	69	68	70	37	70	66
* Discharge to NH	SN/NH/ Home	A	90	83	87	80	85	61	84	82
			n=47	n=15	n=84	n=120	n=248	n=59	n=514	n=573
Discharge to NH	SN or NH	B	55	40	67	68	62	51	63	62
			n=49	n=15	n=85	n=121	n=254	n=67	n=524	n=591
Discharge to NH or Sheltered Housing	SN or NH	B	53	40	67	68	63	45	63	61
			n=20	n=11	n=48	n=66	n=127	n=25	n=272	n=297
Discharge to NH	SN(3)	C	30	36	35	30	30	24	31	31
Discharge to NH	SN or NH/ Home(3)	C	75	82	77	73	75	60	75	74
			n=26	n=16	n=60	n=70	n=144	n=48	n=316	n=364
Discharge to NH or Sheltered Housing	SN or NH/ Home(3)	C	62	62	67	71	70	44	69	65

* $p < 0.05$

(1) The entries in this table represent the number of patients with MD bills submitted within 3 months after discharge/the number of patients alive as of 3 months after discharge × 100.
(2) Type of bill submitted within 3 months post-discharge
(3) Pre period is 1982 only
(4) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture but not depression
(5) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture, AND depression.

Table E.18

USING MEDICARE PART B BILLS TO STUDY USE OF POST-DISCHARGE SERVICES: VALIDATING THE DATA BASE FOR 5 DISEASES COMBINED PRE- AND POST-PPS BY COMPARING NURSING HOME OR HOME BILLS

			Sample Size for 5 Diseases (4)		Patients with MD bills submittd within 3 months after discharge (%)(1)		
Patient Type	Type of Bill(2)	State	Pre-PPS n	Post-PPS n	Pre-PPS	Post-PPS	t-value
Discharge to NH	Any	A	168	204	88	93	1.62
Discharge to NH	SN	A	168	204	62	63	0.04
Discharge to NH	SN or NH	A	168	204	71	78	1.43
Discharge to NH or Sheltered Housing	SN or NH	A	189	230	66	73	1.53
* Discharge to NH	SN/NH/Home	A	168	204	80	88	1.91
Discharge to NH	SN or NH	B	219	295	54	69	3.53*
Discharge to NH or Sheltered Housing	SN or NH	B	224	304	53	69	3.83*
Discharge to NH	Any(3)	C	91	181	89	82	1.65
Discharge to NH	SN(3)	C	91	181	36	29	1.61
Discharge to NH	SN or NH/ Home(3)	C	91	181	78	73	0.83
Discharge to NH or Sheltered Housing	SN or NH/ Home(3)	C	105	211	70	68	0.24

* $p < 0.05$

(1) The entries in this table represent (the number of patients with MD bills submitted within 3 months after discharge/the number of patients alive as of 3 months after discharge) × 100.
(2) Type of bill submitted within 3 months post-discharge.
(3) The pre-PPS period is 1982 only.
(4) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture but not depression

Table E.19

USING MEDICARE PART B BILLS TO STUDY USE OF POST-DISCHARGE SERVICES: VALIDATING THE DATA BASE FOR 5 DISEASES COMBINED PRE- AND POST-PPS BY COMPARING NURSING HOME OR HOME BILLS

			Sample Size for 5 Diseases (4)		Patients with MD bills submittd within 3 months after discharge (%)(1)		
Patient Type	Type of Bill(2)	State	Pre-PPS n	Post-PPS n	Pre-PPS	Post-PPS	t-value
Discharge to NH	Any	A	168	204	88	93	1.62
Discharge to NH	SN	A	168	204	62	63	0.04
Discharge to NH	SN or NH	A	168	204	71	78	1.43
Discharge to NH or Sheltered Housing	SN or NH	A	189	230	66	73	1.53
* Discharge to NH	SN/NH/Home	A	168	204	80	88	1.91
Discharge to NH	SN or NH	B	219	295	54	69	3.53*
Discharge to NH or Sheltered Housing	SN or NH	B	224	304	53	69	3.83*
Discharge to NH	Any(3)	C	91	181	89	82	1.65
Discharge to NH	SN(3)	C	91	181	36	29	1.61
Discharge to NH	SN or NH/ Home(3)	C	91	181	78	73	0.83
Discharge to NH or Sheltered Housing	SN or NH/ Home(3)	C	105	211	70	68	0.24

* $p < 0.05$

(1) The entries in this table represent (the number of patients with MD bills submited within 3 months after discharge/the number of patients alive as of 3 months after discharge) × 100.

(2) Type of bill submitted within 3 months post-discharge.

(3) The pre-PPS period is 1982 only.

(4) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture but not depression

Table E.20

USING MEDICARE PART B BILLS TO STUDY PROLONGED POST-ADMISSION NURSING HOME STAY BY DISEASE FOR PATIENTS HOME PRIOR TO ADMISSION

		Patients with MD bills submitted within months 5, 6, or 7 after admission (%)(1)							
Type of Bill(2)	State	CHF	AMI	PNE	CVA	HIP	DEP	5 DISEASES(3)	6 DISEASES(4)
		n=269	n=280	n=240	n=275	n=302	n=477	n=1366	n=1843
SN	A	3	2	4	10	9	2	6	5
SN or NH	A	5	2	6	14	12	4	8	7
* SN/NH/Home	A	33	12	26	33	45	12	30	25
Office	A	28	47	28	30	18	40	30	33
* Home or office	A	56	57	48	48	52	48	52	51
Any	A	82	75	68	74	72	73	74	74
		n=260	n=267	n=236	n=265	n=263	n=468	n=1291	n=1759
SN or NH	B	5	1	4	18	11	4	8	7
		n=260	n=269	n=259	n=250	n=271	n=428	n=1309	n=1737
SN	C	2	1	2	5	2	2	2	2
SN or NH/ Home	C	23	12	15	28	35	12	23	20
Office	C	31	44	34	33	21	45	32	36
Any	C	69	70	57	70	64	69	66	66

* $p < 0.05$

(1) The entries in this table represent (the number of patients with MD bills submitted within months 5, 6, or 7 after admission/the number of patients alive as of 7 months post-admission) × 100.

(2) Type of bill submitted within months 5, 6, or 7 post-admission.

(3) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture but not depression

(4) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture, AND depression.

Table E.21

Using Medicare Part B Bills to Study Prolonged Post-Admission Nursing Home Stay for Patients Home Prior to Admission Pre- versus Post-PPS

Patients with MD bills submitted within months 5, 6, or 7 after admission (%)(1)

	State	Sample Size Pre-PPS n	Sample Size Post-PPS n	SN Bill Pre-PPS	SN Bill Post-PPS	SN Bill t-value	SN or NH Bill Pre-PPS	SN or NH Bill Post-PPS	SN or NH Bill t-value	SN/NH/Home Pre-PPS	SN/NH/Home Post-PPS	SN/NH/Home t-value
CHF	A	117	152	3.4	3.3	0.05	5.1	4.6	0.19	33.3	32.2	0.19
AMI	A	142	138	1.4	2.2	0.50	1.4	2.9	0.86	8.4	15.9	1.93
PNE	A	124	116	4.0	4.3	0.12	4.8	7.8	0.95	17.7	34.5	3.01*
CVA	A	137	138	8.8	10.9	0.58	10.9	18.1	1.70	28.5	40.0	2.02*
HIP	A	149	153	8.1	9.8	0.52	10.7	12.4	0.46	43.0	47.1	0.72
DEP	A	241	236	0.4	4.2	2.78*	1.2	5.9	2.86*	10.4	12.7	0.79
5 DISEASES(2)A		669	697	5.2	6.2	0.80	6.7	9.2	1.71	26.3	33.6	2.96*
6 DISEASES(3)A		910	933	4.0	5.7	1.70	5.3	8.4	2.64*	22.1	28.3	3.07*

	State	Pre-PPS n	Post-PPS n	SN or NH Bill(1) Pre-PPS	SN or NH Bill(1) Post-PPS	SN or NH Bill(1) t-value
CHF	B	120	140	5.0	5.0	0
AMI	B	129	138	1.6	0.0	1.45
PNE	B	119	117	3.4	4.3	0.36
CVA	B	121	144	19.0	18.1	0.19
HIP	B	121	142	10.7	12.0	0.33
DEP	B	268	200	2.6	7.0	2.15*
5 DISEASES(2)B		610	681	7.9	8.1	0.13
6 DISEASES(3)B		878	881	6.3	7.8	1.23

	State	Pre-PPS n	Post-PPS n	SN Bill Pre-PPS	SN Bill Post-PPS	SN Bill t-value	SN/NH/Home Pre-PPS	SN/NH/Home Post-PPS	SN/NH/Home t-value
CHF	C	122	138	0.8	2.2	0.94	18.0	26.8	1.72
AMI	C	122	147	0.0	2.0	1.73	12.3	12.2	0.03
PNE	C	120	139	1.7	2.2	0.29	11.7	18.7	1.58
CVA	C	116	134	6.0	4.5	0.53	29.3	26.1	0.56
HIP	C	117	154	2.6	1.9	0.38	37.6	32.5	0.87
DEP	C	218	210	1.4	2.4	0.76	10.1	13.3	0.32
5 DISEASES(2)C		597	712	2.2	2.5	0.36	21.6	23.3	0.74
6 DISEASES(3)C		710	922	2.3	2.5	0.26	21.3	21.0	0.15

* $p < 0.05$

(1) The entries in this table represent (the number of patients with MD bills submitted within months 5, 6, or 7 after admission/the number of patients alive 7 months after admission) x 100.

(2) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture but not depression

(3) Includes patients hospitalized with congestive heart failure, acute myocardial infarction, pneumonia, cerebrovascular accident, hip fracture, AND depression.

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